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PREDICTION OF SIX-DEGREE-OF-FREEDOM STORE SEPARATION TRAJECTORIES AT SPEEDS UP TO THE CRITICAL SPEED

Volume II - Users Manual for the Computer Programs

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WRIGHT—PATTERSON AIR FORCE BASE, OHIO 45433

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PREDICTION OF SIX-DEGREE-OF-FREEDOM STORE SEPARATION TRAJECTORIES AT SPEEDS UP TO THE CRITICAL SPEED

Volume II - Users Manual for the Computer Programs

Frederick K. Goodwin
Marnix F. E. Dillenius

FOREWORD

This report, "Prediction of Six-Degree-of-Freedom Store Separation Trajectories at Speeds up to the Critical Speed," describes a combined theoretical-experimental program directed toward developing a computer program for predicting the trajectory of an external store separated from an aircraft of the fighter-bomber type at speeds up to the critical speed. Volume I, "Theoretical Methods and Comparisons with Experiment," describes the theoretical approach and presents extensive comparisons with experimental data. This volume, Volume II - "Users Manual for the Computer Programs," presents detailed instructions on the use of the computer programs.

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The authors wish to thank Mr. Jenkins for his assistance during the course of the investigation. The computer program card decks are available upon request from Mr. Jenkins. His address is AFFDL/FGC, Wright-Patterson AFB, Ohio, 45433.

The work documented in this report was started on December 11, 1970 and was effectively concluded with the submission of this report. The report was submitted by the authors in June 1972.

This technical report has been reviewed and is approved for publication

FOR THE COMMANDER

Jerry E. Jenkins

JERRY E. JENKINS
Project Engineer
Flight Control Division

E. H. Flinn

E. H. FLINN, Chief
Control Criteria Branch
Flight Control Division

ABSTRACT

Detailed instructions are presented for using two computer programs which calculate the six-degree-of-freedom trajectories of external stores which are separated from fighter-bomber type aircraft at speeds up to the critical speed. Single and multiple store configurations can be handled by the programs. The first program calculates the source distributions which represent the volume distributions of the fuselage, store(s), and ejector rack if one is present. The second program uses a lifting surface theory to determine a vorticity distribution which represents the wing and pylon loading and calculates the trajectory of the ejected store. This report describes the two programs, presents instructions for preparing input for the programs, describes the output from each program, and presents sample cases.

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LIST OF ILLUSTRATIONS

LIST OF SYMBOLS

a_{max}	maximum store body radius
c	local wing chord
c_{d_c}	section drag coefficient of a circular cylinder normal to airstream
C_A	axial-force coefficient, axial force/$q_{\infty_s} S_R$
C_ℓ	rolling-moment coefficient, rolling moment/$q_{\infty_s} S_R \ell_R$
C_m	pitching-moment coefficient, pitching moment/$q_\infty S_R \ell_R$
C_n	yawing-moment coefficient, yawing moment/$q_{\infty_s} S_R \ell_R$
C_N	normal-force coefficient, normal force/$q_{\infty_s} S_R$
C_Y	side-force coefficient, side force/$q_{\infty_s} S_R$
d	maximum diameter of store
I_{xx}, I_{yy}, I_{zz}	moments of inertia about x,y,z axes of figure 21; taken about store moment center
ℓ	store length
ℓ_R	reference length; store maximum diameter, d
M_∞	aircraft free-stream Mach number
p,q,r	rotational velocities about x,y,z axes of figure 21; positive as shown in figure 22
q_∞	free-stream dynamic pressure; $1/2\ \rho_\infty V_\infty^2$
q_{∞_s}	ejected store free-stream dynamic pressure; $1/2\ \rho_\infty V_{\infty_s}^2$
Q	strength of a point source
Q^*	$Q/4\pi\ell^2 V_\infty$
r	body radius
s	semispan of wing

S_R	reference area taken equal to body frontal area, πa^2_{max}
t	time
U_s, V_s, W_s	total velocities as seen by store, positive in x_s, y_s, z_s
V_∞	aircraft free-stream velocity
V_{∞_s}	separated store free-stream velocity
x, y, z	coordinate system in compressible space
x', y', z'	coordinate system in incompressible space
x_B, y_B, z_B	coordinate system fixed in fuselage with the origin at nose, see figure 13
x_ℓ, z_ℓ	coordinate system fixed in local airfoil section of twisted wing, see figure 15(b), with x_ℓ lying along chord line
x_s, y_s, z_s	coordinate system in compressible space fixed in separated store with origin at store nose (fig. 21)
x_w, y_w, z_w	coordinate system fixed in wing with origin at root-chord leading edge, see figure 14
α_ℓ	local angle of attack due to wing twist and camber
Γ	strength of a horseshoe vortex
θ	local slope of wing thickness envelope
ξ, η, ζ	inertial coordinate system fixed in fuselage nose, positive forward along longitudinal axis, positive laterally to the right, and positive vertically downward respectively, see figure 22
ρ_∞	free-stream mass density
Ψ, Θ, Φ	store yaw, pitch and roll angles specifying angular orientation of store x,y,z coordinate system relative to ξ, η, ζ inertial system, see figure 22

PREDICTION OF SIX-DEGREE-OF-FREEDOM STORE SEPARATION TRAJECTORIES AT SPEEDS UP TO THE CRITICAL SPEED

Volume II - Users Manual for the Computer Program

1. INTRODUCTION

The purpose of this volume of the report is to describe and present instructions for using the two computer programs developed in conjunction with the theoretical work presented in Volume I, reference 1. The programs as described in this report have been run on both the CDC 6600 and Univac 1108 computers. The programs should run with very little, if any, modification on other computers with large enough memory capacity. The largest of the two programs requires approximately 110,000 octal words of core storage. No tapes, drums, or disks are used by either program. All input to the programs is from cards and all output is printed.

The two programs are

(1) Source distribution program
(2) Six-degree-of-freedom trajectory program

The source-distribution program is used to obtain source-sink distributions to represent the fuselage, rack, and store volumes. The trajectory program uses these source-sink distributions and additional information to first determine the vorticity distribution which represents the wing-pylon loading including interference of the fuselage, rack, and stores and then to calculate the store trajectory.

The next sections of this report will describe in more detail the general use of the programs and then present instructions for preparing the input data and interpreting the output. Details of the two programs are contained in two appendices.

The method of describing the aircraft components, the aircraft operational parameters, and the dynamical characteristics of the stores are of importance. The various parameters which are included in the computer program are

Wing Panels

Thickness distribution: Specified at large number of chordwise locations and at the same number of spanwise locations as used in the vortex lattice which represents the wing as a lifting surface.

Mean camber surface: May have both twist and camber.

Leading-edge shape: Represented by straight line segments of differing sweep.

Trailing-edge shape: Also represented by straight line segments of differing sweep.

Taper: Controlled by shape of leading and trailing edges.

Dihedral: Variable across wing panel.

Fuselage

Shape: Body of revolution.

Pylon

Thickness distribution: Same method of description as for wing panel.

Mean camber surface: Planar.

Orientation: Vertical and streamwise.

Leading-edge shape: Straight but can be swept.

Trailing-edge shape: Straight but can be swept.

Taper: Uniform taper.

Tip: Parallel to pylon root chord.

Number: One pylon per wing panel.

Rack

Shape: Body of revolution.

Stores

Shape: Body of revolution.

Number of stores: Ten, either singly or in MER or TER configurations.

Attached orientation: Initial pitch angle arbitrary, initial yaw angle zero.

Empennage: Planar or cruciform empennage.

Initial roll orientation: Arbitrary.

Power: Unpowered.

Airplane Operating Characteristics

Flight path: Straight but not necessarily horizontal.

Flight velocity: Constant.

Density: Constant.

Angle of attack: Constant.

Yaw angle: Zero.

Store Inertial Characteristics

Moments of inertia: Constant.

Products of inertia: Constant.

Center of gravity position: Not necessarily on store longitudinal axis.

Store Ejection Conditions

Initial velocity: In vertical plane normal to store longitudinal axis.

Initial pitching velocity: Arbitrary.

Initial yawing velocity: Zero.

Initial rolling velocity: Zero.

2. GENERAL DESCRIPTION OF THE USE OF THE PROGRAMS

The computer program which has been written to calculate the trajectory of a store separated from an aircraft consists of two programs, an axisymmetric source distribution program and a trajectory program. The calculation of the source distributions to represent the various axisymmetric bodies has been kept separate for two reasons. First, a number of runs may have to be made with the program to obtain a source distribution which adequately reproduces the shape of the body. The second reason is that once the source distribution is obtained for a specific Mach number it need not be recalculated since for a given body shape the distribution is only a function of Mach number.

2.1 Source Distribution Program

For a given aircraft-stores combination and Mach number, source distributions must be obtained for the fuselage, each different store shape, and the ejection rack if one is present. The actual shape of each body, made dimensionless by the length, must be approximated by a body of

revolution and specified by a series of segmented polynomials. If the body has a blunt base, the wake must be modeled by extending the body until it closes. If compressibility is to be accounted for in the vortex lattice and trajectory calculations, that is, the Mach number, M_∞, is not to be specified as zero, then source distributions must be obtained for each Mach number of interest. The program determines the equivalent incompressible body by applying the transformation given by equation (1) of reference 1. The compressibility correction stretches the body by $1/\sqrt{1 - M_\infty^2}$. In the trajectory calculation an aircraft velocity must be specified. This need not be consistent with the Mach number so that for low flight speeds the Mach number zero shapes can be used. The program calculates and prints the source locations and strengths. These quantities are used as input data to the trajectory program.

2.2 Trajectory Program

After the source distributions which represent the volume distributions of the fuselage, all of the stores, and the rack, if one is present, have been determined the trajectory program is ready to be run. This program consists of three main sections. The first section reads in the input data and calculates quantities from these data, the second section solves for the vorticity distribution which represents the wing-pylon loading, and the third section calculates the trajectory.

2.2.1 Input section

The input section of the program reads in the following information

(1) Aircraft flight conditions
(2) Indices specifying what aircraft components are present
(3) Fuselage data
(4) Wing data
(5) Pylon data
(6) Rack data
(7) Store data

The aircraft flight conditions, item (1) above, which can be varied are the angle of attack, flight path angle, Mach number, free-stream air density, and flight velocity. The Mach number must be consistent with that used to calculate the source distributions.

Item (2) consists of four indices. The first three specify whether or not the fuselage, pylon, and rack are present and the fourth specifies the number of stores. The program in its present form will handle a maximum of ten stores. This limit is imposed by dimension statements in the program and could be changed.

The fuselage input data consist of the length, maximum radius, and source distribution.

The wing input data locate the wing relative to the fuselage, including its incidence, and supply information required to lay out the vorticity and thickness distributions. The data also include the twist and camber distribution and the slope distribution of the thickness envelope. The wing leading and trailing edges can have breaks in sweep. The wing dihedral angle does not have to be constant over the semispan.

Similarly, the pylon input data locate the pylon from which the store is to be separated and provide information required to lay out the vorticity and thickness distributions. The pylon is located laterally relative to the fuselage centerline and longitudinally relative to the leading edge of the local wing chord. The data also include the slope distribution of the thickness envelope. The pylon cannot have twist or camber. The leading and trailing edges can be swept at constant but different sweep angles.

The rack, if one is present, is located immediately below the pylon. The input data for the rack locate its nose relative to the local wing chord and specify its incidence relative to the wing root chord. In addition, the rack length, maximum radius, and source distribution are input.

Data are input for each store present on the aircraft which assigns a store number and specifies a shape number, the length, and the maximum radius. Each store is located by specifying its lateral position relative to the wing root chord and the longitudinal and vertical position of the store nose relative to the wing chord immediately above the store. The incidence of the store relative to the wing root chord is also specified. A source distribution is input for each different store shape. Data should be input for all stores close enough to the store being separated to affect its trajectory. The separated store must be under the fuselage centerline or to the left of this line as seen by the pilot. For store-to-store

interference calculations, the program does not assume that the same stores exist to the right. Thus data must be input for stores on that side if they are close enough to affect the trajectory. The vortex-lattice calculation requires left to right symmetry. Thus, for this calculation the program ignores all stores input to the right of the fuselage centerline and assumes all stores input on the left side exist on the right.

2.2.2 Vortex-lattice section

The second main section of the program calculates the wing-pylon vorticity distribution. This is done using equations (6) and (7) of section 4.2.2 of reference 1. Before performing this calculation all of the aircraft components are located relative to the fuselage and then the entire configuration is transformed into an equivalent incompressible one using equation (1) of reference 1. The coefficient matrix is then calculated and the right-hand side is determined. Finally, the strengths of the vortices are calculated by solving the set of simultaneous equations.

2.2.3 Trajectory section

The third and last main section of the trajectory program is the trajectory calculation which consists of the following steps

(1) Input additional information to describe separated store
(2) Input empennage data if store has one
(3) Initialize for trajectory calculation
(4) Calculate aerodynamic forces and moments
(5) Calculate accelerations and rates of change of orientation angles
(6) Integrate equations of motion
(7) Repeat steps (4), (5), and (6) to end of trajectory

The additional data describing the store to be separated include indices specifying which store is to be separated, the number of segments the body is to be broken into for the force calculation, the flow separation location, and whether the store has an empennage. Also, the store mass and inertia characteristics are read in along with the location of the point about which the aerodynamic moments are to be calculated. This is the point about which the moments and products of inertia were calculated. The location of the store center of mass relative to this point is also specified as are the store axial-force coefficient and the value of the crossflow-drag coefficient to be used in the viscous crossflow force and moment calculation.

Three other indices are input which pertain to options included in the computer program. Provision has been made to include or exclude the damping terms in the velocity field calculation. Also, for stores with empennages, rolling moment may or may not be included in the acceleration determination. The third option pertains to the calculation of free-flight trajectories as opposed to captive-store trajectories as obtained in the wind tunnel. In wind-tunnel captive-store testing it is customary to change the store pitch and yaw angles to account for translational motion only while measuring the aerodynamic forces and moments. This changes its position in the nonuniform flow field. Provision has been made in the computer program to simulate this.

For a store with an empennage, additional quantities must be specified. These data are an index indicating whether the empennage is planar or cruciform, the tail-fin semispan, the average body radius in the tail-fin region, the initial roll orientation of the fins, and the lift-curve slope of the fins alone. In addition the axial position at which the forces are assumed to act must be specified.

In the trajectory initialization certain store separation conditions are specified. These are an initial translational velocity in the vertical plane containing the store longitudinal axis and an initial pitching velocity. The store axial and lateral velocities and yawing and rolling rotational velocities are initially zero.

The integration of the equations of motion is done by a standard numerical integration technique with the aerodynamic forces and moments calculated at each point required by the integration scheme. The calculation of the nonuniform velocity field and the resulting forces and moments is described in section 5 of reference 1.

For a given aircraft-store combination and Mach number, it can be seen that a series of trajectories can be run with only minor changes to the input data deck. For example, the aircraft angle of attack can be varied by changing one number on one card as can the aircraft flight path angle. The altitude can be varied by changing the free-stream density and possibly the free-stream velocity to account for changes in the speed of sound. Among other things easily varied are the store mass and inertia properties, center of gravity location, and ejection conditions.

Provision has also been made for restarting a trajectory. This is accomplished by changing one card which specifies the initial and final times and adding two cards specifying the current values of the dependent variables. These are tabulated in the output at each integration step.

3. SOURCE DISTRIBUTION PROGRAM

The purpose of this program is to calculate the source-sink distributions which are required to represent the volume distributions of the fuselage, rack, and stores. The actual body shapes must be approximated by bodies of revolution. The program consists of the main program and two subroutines called SHAPE and INVERS. A listing of the program is presented in figure 1 and a flow chart in figure 2.

The program listing in figure 1 is specifically for the CDC 6600 computer. To run the program on other machines such as the Univac 1108 the three unsequenced statements following sequence number SORA1 34 in the main program may have to be removed or changed.

3.1 General Description of Program

The flow chart of figure 2 shows that the first function that the program performs is to read in all the required input data and to print it out. Next the locations at which sources are to be placed are determined. The location of the first source is specified by the input data as is the distance between sources in terms of a fraction of the local body radius. Thus the location of each successive source is determined from the location of the previous one and the radius at that point. Subroutine SHAPE calculates the radius and local surface slope from the equations describing the body. The program in its present form will handle up to 100 sources. If it tries to lay out more than this number a message indicating this is printed and the calculation is terminated.

The program next determines the body radius and surface slope at the points on the body where the surface boundary condition is to be imposed. This is discussed in sections 4.1.2 of reference 2. The points are located axially midway between two adjacent sources. One location, which is just forward of the location at which the body first reaches its maximum thickness, is eliminated. Thus, the surface boundary condition is imposed at (N-2) locations where N is the number of sources.

The next part of the program calculates the coefficient matrix and the right-hand side of the set of simultaneous equations to be solved for the source strengths. Equations (19) through (21) of reference 2 are used. Following this, subroutine INVERS is called to solve for the source strengths.

The last section of the program takes the source distribution just determined and calculates the shape of the body represented by it. This shape should be compared with the known shape and if the representation is inaccurate a new source distribution should be tried. This will be discussed further in section 3.2.1.

The shape given by the source distribution is obtained from the equation for the stream function, ψ^*, equation (14) of reference 2. Since one of the boundary conditions imposed is that the nose is a stagnation point the body shape will be given by the $\psi^* = 0$ line.

A detailed description of the main program and the two subroutines is presented in Appendix I.

3.2 Input Data

3.2.1 Input format

The format of the input data for the source distribution program is shown in figure 3. Three lines of information are shown for each item. The first line gives the program variable names. The second line shows the card column fields into which the data are to be punched, and the third line shows the FORTRAN format type. Data punched in I format are right justified in the field, whereas data in F format can be punched anywhere in the field. A decimal point should be included in F-type data.

Item number 1 is an index NCARDS which indicates how many cards of information are to follow to identify the run, item number 2. The value of NCARDS must be one or greater.

Item number 2 is a set of NCARDS cards containing hollerith information which may start and end anywhere on the card. The cards are reproduced in the output just as they are read in.

Item number 3 consists of one card with one index, NSECT, and the Mach number, FMACH. The index NSECT specifies the number of segmented polynomials being used to represent the body. The maximum value of NSECT is seven, that is,

$$1 \leq \text{NSECT} \leq 7$$

The next two items, items number 4 and 5, of input data are associated with the polynomials used to describe the body shape and the wake. The polynomial programmed in subroutine SHAPE is

$$\frac{r}{\ell} = C_1 + C_7\sqrt{C_2\left(\frac{x}{\ell}\right)^2 + C_3\left(\frac{x}{\ell}\right) + C_4} + C_5\left(\frac{x}{\ell}\right) + C_6\left(\frac{x}{\ell}\right)^2 \qquad (1)$$

where C_1 through C_7 are the coefficients, r is the local body radius, and ℓ is the body length. The source distributions must be calculated for shapes which are made dimensionless by the body length since the trajectory program is written assuming this to be the case. This length is the length of the body and does not include the additional length due to the addition of a wake.

The polynomials are for the actual body, not the equivalent $M_\infty = 0$ body. The equivalent incompressible body is determined by the program. The transformation given by equation (1) of reference 1 is applied to the actual shape. This transformation is

$$x' = \frac{x}{\sqrt{1 - M_\infty^2}}, \quad y' = y, \quad z' = z \qquad (2)$$

Therefore the body is lengthened by a factor $1/\sqrt{1 - M_\infty^2}$.

As was mentioned previously, items number 4 and 5 on figure 3 are input data associated with the polynomials specifying the shape of the actual axisymmetric body. Item 4 consists of one card which contains the NSECT values of the end points of the polynomials describing the shape. The decimal point can be placed anywhere in the ten-column field.

Item number 5 on figure 3 is a set of NSECT cards specifying the values of the coefficients of the polynomials, equation (1). All seven coefficients are input even though many of them may be zero.

Item number 6 on figure 3 is the last card of input data. The eight quantities are

XSFST value of x/ℓ at which the first source is to be placed

XSLST value of x/ℓ beyond which no source is to be placed

PERCR — fraction of the local body radius between sources

XRMAX — value of x/ℓ at which maximum radius or thickness is first reached

XINIT — initial value of x/ℓ at which body radius is to be calculated from source distribution

XFINAL — final value of x/ℓ at which body radius is to be calculated from source distribution

DELX — increment between points at which body radius is to be calculated from source distribution

RMAX — maximum value of r/ℓ of actual body

The first four quantities are used in calculating the source distribution. The values of XSFST and PERCR are important in obtaining a good representation of the body shape. The location of the first source, XSFST, controls how well the nose of the body is modeled. A value of 0.001 or 0.002 has been found to be satisfactory. If the value is too large, the nose will generally be blunter than desired. The correct value of PERCR is found by trial and error. A procedure which has been found to work quite well is to make a calculation with PERCR = 1.0. If the shape generated by the resulting source distribution is not adequate, that is, too large in diameter or contains ripples of undesirable magnitude, then PERCR should be decreased. If an excellent fit is obtained a larger value of PERCR should be tried. From the standpoint of computation time during the trajectory calculation, the number of sources should be minimized.

The value of XSLST must be at least 0.005 less than the length of the body. For blunt-based bodies which are extended to model a wake, the value must be at least 0.005 less than the x/ℓ of the end of the wake. The quantity XRMAX is self-explanatory.

The last four quantities on the last card pertain to the calculation of the shape represented by the source distribution. This shape is to be compared with the known body shape to determine the accuracy of the source distribution. Hence, a sufficiently small value of DELX should be used so that details of the calculated shape can be seen.

3.2.2 Sample input data

Four sets of sample input data for the source distribution program are shown in figure 4. These are data used to calculate source distributions to model the volume distributions of the various bodies used in the wind-

tunnel tests performed in conjunction with the present work. The various components of the wind-tunnel model are shown in figure 5.

Referring to figures 3 and 5(d), first consider the input data for the ogive-cylinder store shown in figure 4(a). The first card contains NCARDS, which is 2, and the next two cards are these two cards of identifying information. The next card contains NSECT and FMACH. The body, including its wake, is to be represented by three polynomials, NSECT = 3, of the type given by equation (1). The Mach number, FMACH, is 0.4. Examining figure 5(d) it is seen that the nose is an ogive 1.5 inches long so that it ends at (ℓ is the store length)

$$\frac{x}{\ell} = \frac{1.5}{6.375} = 0.2353$$

The cylindrical section ends at $x/\ell = 1.0$. To model the wake let us use the same shape as the nose. Therefore, the wake terminates at $x/\ell = 1.2353$. The end points of these three polynomials are contained on the next card, card 5 of figure 4(a).

The next three cards contain the coefficients of the polynomials for the three sections (see eq. (1)). The nose section is a circular arc so that when the following boundary conditions are imposed

$$\frac{x}{\ell} = 0 \qquad \frac{r}{\ell} = 0$$

$$\frac{x}{\ell} = 0.2353 \qquad \frac{r}{\ell} = \frac{0.375}{6.375} = 0.05882$$

$$\frac{x}{\ell} = 0.2353 \qquad \frac{dr}{dx} = 0$$

the equation of a circle gives

$$\frac{r}{\ell} = -0.4413 + \sqrt{-\left(\frac{x}{\ell}\right)^2 + 0.4706\,\frac{x}{\ell} + 0.1947} \tag{3}$$

The cylindrical section runs from $x/\ell = 0.2353$ to $x/\ell = 1.0$ and in this region

$$\frac{r}{\ell} = 0.05882 \tag{4}$$

The wake is also a circular arc. By imposing the following three boundary conditions

$$\frac{x}{\ell} = 1.0 \qquad \frac{r}{\ell} = 0.05882$$

$$\frac{x}{\ell} = 1.0 \qquad \frac{dr}{dx} = 0$$

$$\frac{x}{\ell} = 1.2353 \qquad \frac{r}{\ell} = 0$$

we obtain

$$\frac{r}{\ell} = -0.4413 + \sqrt{-\left(\frac{x}{\ell}\right)^2 + 2.0\,\frac{x}{\ell} - 0.7499} \tag{5}$$

Equations (3), (4), and (5) are the three polynomials describing the shape of the store and the coefficients are contained in cards 6 through 8 of figure 4(a).

The last card of figure 4(a) contains the remaining input data. The first number, XSFST, specifies that the first source is to be located at $x/\ell = 0.002$. The second number, XSLST, indicates that no source is to be placed behind $x/\ell = 1.23$ and the third number, PERCR, requires that the source spacing be 0.7 times the local value of r/ℓ. The fourth quantity on this card, XRMAX, specifies that the maximum body radius is first reached at $x/\ell = 0.2353$. The next three quantities specify the values of x/ℓ at which the body radius is to be calculated from the source distribution. The first value of x/ℓ, XINIT, is 0.01, the last value, XFINAL, is 1.23, and the interval between points, DELX, is 0.02. The last quantity on this card, RMAX, if the maximum value of r/ℓ for the store, 0.05882.

The remaining three sets of input data shown in figure 4 are for the fuselage, figure 5(a), the small boattail store, figure 5(e), and the TER rack, figure 5(c). The fuselage is represented by a circular arc nose, a cylindrical centerbody, and a circular arc afterbody which is allowed to close aft of the actual base of the fuselage in order to model the wake.

Table I presents the coordinates of the small boattail store. Examination of figure 4(c) shows that this body is approximated by a series of circular arcs except for the short cylindrical section at the base of the body. The wake is again modeled by a circular arc.

The TER rack shown in figure 5(c) can be approximated by a body of revolution to which are attached three short pylons. In the present programs the pylons are not accounted for and a source distribution is used to model the body of revolution. The input data of figure 4(d) shows that the nose is approximated by an ellipse, the center section by a cylinder, and the aft end by a circular arc. Again, this aft section is extended until it closes in order to model the wake.

3.3 Output from the Program

The output data from the source distribution program for the four sets of input data shown in figure 4 are presented in figures 6 through 9. Figure 6 is the output for the ogive-cylinder store; figure 7, the output for the fuselage; figure 8, the output for the small boattail store; and figure 9, the output for the triple ejector rack.

Part (a) of each figure is page 1 of the output. This page tabulates most of the input data. Page 2 of the output, part (b) of each figure, tabulates the x/ℓ locations at which the sources were placed along with the values of r/ℓ and dr/dx calculated from the input polynomials at these values of x/ℓ.

Page 3 of the output, part (c) of each figure, specifies the number of sources, the Mach number, the values of x/ℓ at which the sources are located, and also the dimensionless incompressible source strengths. These are tabulated in the format in which they are to be punched (6E12.4) for input into the trajectory programs. They are not punched in the order shown. The values of x/ℓ are first punched and then beginning on a new card the values of Q are punched.

Page 4 of the output, part (d) of each figure, lists the shape calculated from the source distribution. Tabulated as a function of x/ℓ is the calculated r/ℓ. This radius distribution should be compared with that given by the polynomials used to represent the body. If the two shapes do not agree to the desired accuracy, then the location of the first source and the source spacing should be varied in order to attempt to improve the representation.

4. SIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM

The six-degree-of-freedom trajectory program uses the source distributions, calculated as described in the preceding section, as input data. In addition other data are input describing the various components of the aircraft and locating them with respect to each other as well as data describing the aircraft flight conditions. The vorticity distribution representing the wing-pylon loading is next determined and following this additional data describing the separated store are read in and the trajectory calculation performed.

The program just described consists of a main program and 32 subroutines. Table II lists these subroutines in alphabetical order and gives a one-sentence description of what each subroutine does. A listing of the six-degree-of-freedom trajectory program and its 32 subroutines is presented in figure 10 and a general flow chart of the main program in figure 11. The program listing in figure 10 is specifically for the CDC 6600 computer. To run it on other machines such as the Univac 1108 the three unsequenced cards following sequence number 6DA01124 in the main program may have to be removed or changed. A detailed description of the program and subroutines, including the equations programmed, is presented in Appendix II.

4.1 General Description of Program

The computer program integrates the six-degree-of-freedom equations of motion, which are derived in Appendix II of reference 1, in the manner described in section 6 of that reference. The aerodynamic forces and moments are calculated by the methods presented in section 5 of that report.

A general flow chart of the program is presented in figure 11. Page 1 of the flow chart, figure 11(a), is the input section of the program. Constants are defined and heading information is read and printed. The aircraft flight conditions are input as are indices specifying what aircraft components are present. If the fuselage is present the fuselage data are read in and printed.

The next steps in the program read in the data required to model the wing. The data locating the wing and specifying its incidence relative to the fuselage are first read and then subroutine WVLIN is called. This

routine reads in the data required to lay out the vortex lattice which will represent the loaded wing and lays out the lattice. In addition it reads in the twist and camber distribution at the vortex lattice control points. The last wing input data is the thickness distribution. These data are read in by subroutine WTHIN.

A check is made in the program to determine whether or not a pylon is present. If it is, data describing the pylon are read and subroutines PVLIN and PTHIN are called to read in the data required to lay out the pylon vortex lattice and thickness distribution. Following this the pylon is located in the fuselage coordinate system.

The next two steps in the program call subroutines VLOUT and THOUT which output the vortex lattice and thickness distribution data. The vortex strengths are calculated and tabulated later.

One of the optional aircraft components is the ejection rack. If one is present the next steps in the program input all of the data describing and locating the rack. The input data locate the rack relative to the local wing chord. Calculations are made which locate it in both the wing and fuselage coordinate system.

Provision has been made for not including any stores in the input data. This has been done so that the program can be used to determine the coordinates of the points at which the wing twist and camber distribution must be input. The next step in the program checks to see if there are any stores and if there are none the store input section of the program is bypassed. If there are stores, subroutine STRIO is called to read in and print all of the store data. These data consist of the locations and incidences of all the stores and a source distribution for each different shape. After all of these data are input, each store is located in the fuselage coordinate system.

Boxes 2 through 5 of the left-hand column of figure 11(b) are associated with the calculation of the vorticity distribution to represent the wing-pylon loading. The equations used to solve for the vorticity distribution are equations (6) and (7) of section 4.2.2 of reference 1. The first step is to call subroutine VLCOEF which calculates the coefficient matrix, that is, the coefficients multiplying the unknown vortex strengths, Γ_n, in equations (6) and (7). The next step is to call

subroutine VLRHS which calculates the right-hand side of this set of simultaneous equations. The resulting set of equations are then solved by calling subroutine INVERS. Subroutine VSTOUT is called to output the resulting vortex strengths, control point coordinates, and interference velocities at these points. If there are no stores present this ends the calculation and the program returns to the beginning to read another set of input data.

If stores are present the program continues and reads in the additional data required to describe the store to be separated and performs the initialization for the trajectory calculation. The remainder of the flow chart of figure 11(b) shows this part of the programs. First the additional data describing the store are read in. These data consist of, among other things, the mass and inertia characteristics, polynomials defining the body shape, and center of gravity location. The next step is to calculate other quantities from these data.

If the store to be separated has an empennage the data required to describe the empennage are input and subroutine EMPINI is called to initialize for the empennage force and moment calculation.

Provision is made in the program for prescribing initial vertical and pitching velocities relative to the parent aircraft. These are next read in and then the initial values of the 12 dependent variables in the trajectory calculation are computed. These are

(1) The three coordinates of the store center of moments relative to the fuselage nose.

(2) The three translational velocity components of the store center of moments relative to the fuselage.

(3) The three store rotational velocities.

(4) The three angles giving the store orientation relative to the fuselage.

Reference positions of the store nose, center of moments, and base are next calculated and the initial and final trajectory times, as well as a guess at the integration interval, are input. If the initial time is not zero, then the trajectory is being restarted from a previous run and the current values of the 12 dependent variables obtained from that run are

read in. The last step in the initialization is to initialize subroutine ADAMS, the integration routine.

The last page of the flow chart, figure 11(c), is the integration loop of the program. The first steps are to calculate the aerodynamic forces and moments acting on the body and the empennage, if one is present, of the separated store. The body forces and moments are determined by the methods described in section 5.2 of reference 1. The empennage forces and moments are determined as discussed in section 5.3 and Appendix I of that reference.

One of the options in the computer program is to calculate a wind-tunnel captive-store trajectory as opposed to a free-flight trajectory. It is customary in the wind tunnel to change the store orientation relative to the parent aircraft while measuring the forces and moments in order to approximately account for the store translational motion relative to the aircraft. The computer program also does this during the force and moment calculation. Thus, if a captive store trajectory is being calculated, the next step in the program is to put the store back to its correct orientation and call subroutine DIRCOS in order to calculate the free-flight direction cosines between the store body coordinate system and the inertial coordinate system which is fixed in the fuselage.

The next series of steps determines the store translational and rotational accelerations. This involves solving the set of six simultaneous equations given by equations (II-16) through (II-18) and (II-41) through (II-43) of Appendix II of reference 1 making use of the relationships given in section 6.1 of that reference. The coefficient matrix is first calculated and then the right-hand sides are determined. Subroutine INVERS is called to solve the set of six equations for the accelerations. The rates of change of the orientation angles are next determined from equation (II-1) of Appendix II of reference 1.

A check is next made to see if output is to be printed at the end of an integration step. If output is not required the integration continues by calling subroutine ADAMS. If it is required, subroutine OUTPUT is called. Upon return from this subroutine a check is made to see if the time is equal to the final time which was read in and if so, the trajectory is stopped and control returns to the beginning to read in a new set of data. If it is not, the integration is continued.

4.2 Input Data

4.2.1 Input format

The format for the input data for the trajectory program is shown in figure 12. Three lines of information are shown for each item. The first line gives the program variable names, the second line shows the card column fields into which the data are to be punched, and the third line shows the FORTRAN format type. Data punched in I and E formats are right justified in the fields whereas data in F format can be punched anywhere in the field. A decimal point should be included in both E- and F-type data.

Item number 1 is an index NCARDS which indicates how many cards of information are to follow to identify the run, item number 2. The value of NCARDS must be one or greater.

Item number 2 is a set of NCARDS cards containing hollerith information identifying the run and may start and end anywhere on the card. The cards are reproduced in the output just as they are read in.

Item number 3 consists of one card and contains the following information:

ALFAC	fuselage angle of attack, degrees
GAMF	fuselage flight path angle, degrees
FMACH	Mach number
RHO	air density at flight altitude, slugs per cubic foot
VINF	aircraft free-stream velocity, feet per second

The aircraft is assumed to be flying in a straight line; however, it can be climbing or diving. For climbing flight, GAMF is positive. The Mach number, FMACH, is used in the compressibility correction. For low flight velocities where compressibility can be ignored, it can be input as zero. FMACH should be the same as that used in calculating the source distributions to be input later.

Item number 4 contains four indices which specify what aircraft components are present. They are

NFU fuselage? NFU = 0, no
NFU = 1, yes

NPY pylon? NPY = 0, no
NPY = 1, yes

NRACK rack? NRACK = 0, no
NRACK = 1, yes

NSTRS number of stores; $0 \leq NSTRS \leq 10$

Provision has been made for omitting the fuselage since for trajectories of stores dropped from near the wing tip the fuselage probably has a negligible influence. For cases with no fuselage the reference coordinate system is fixed at the wing root-chord leading edge and ALFAC and GAMF of item 3 should be the wing angle of attack and flight path angle, respectively. If a rack is present, NRACK = 1, the pylon to which it is attached must also be present, NPY = 1. The number of stores can be zero. This allows the input data deck through item 25 to be checked out without running a trajectory. In addition the program can also be used as an aid in determining the points on the wing and pylon at which the slopes of the camberline and the thickness distribution are to be input.

Item number 5 consists of two quantities which are

FLTHC length of actual fuselage, feet

FRMAX maximum fuselage radius, feet

This item and the next three are omitted if NFU = 0.

Items number 6, 7, and 8 are data specifying the source distribution for the equivalent incompressible fuselage as calculated by the source distribution program. Item number 6, NFSOR, specifies the number of sources. This number is printed at the top of page 3 of the source distribution output, see for example figure 7(c). Item 7, the FXL array, and item 8, the FSOR array, are the locations, x/ℓ, and the dimensionless strengths, Q*, of the NFSOR sources, respectively. These quantities are also printed on page 3 of the source distribution program output, see for example figure 7(c). Item 7 contains all of the x/ℓ's punched six to a card except for the last card which will contain less if NFSOR is not a multiple of 6. Item 8 begins on a new card and contains the Q*'s.

Item number 9 contains three parameters which specify the wing location relative to the fuselage nose and the incidence of the root chord relative to the fuselage longitudinal axis. These three parameters are shown pictorially in figure 13 and are

XBWOC	x_B	location of the wing root-chord leading edge, feet
ZBWO	z_B	location of the wing root-chord leading edge, feet
WIC		incidence angle of wing root chord measured relative to fuselage axis, degrees

The wing root chord is the chord obtained by extending the exposed wing panel to the fuselage x_B, z_B plane of symmetry. All three quantities are measured on the actual, not the equivalent incompressible, configuration. The compressibility correction is made in the program. In the example of figure 13, XBWOC and ZBWO are negative and WIC is positive. If the wing were below the fuselage axis, ZBWO would be positive.

Item number 10 contains two quantities which are

CRW	length of wing root chord, feet
SSPAN	wing semispan, feet

Both quantities are input as positive quantities.

Items 11 and 12 are input data describing the left wing panel which are used to lay out the wing vortex lattice. The quantities are

NCW	number of vortices in a chordwise row on wing
MSW	number of vortices in a spanwise row on wing; also number of thickness strips in a spanwise row on wing; MSW $\leq$ 30
I	wing vortex trailing leg number; I = 1 to MSW+1
Y(I)	y_w location of I^{th} trailing leg on the left wing panel, feet (zero when I = 1, negative for all other I's since on left panel; measured in wing planform plane)
PSIWLE(I)	leading-edge sweep of wing section to the right of the I^{th} trailing leg, degrees; positive swept back (measured in wing planform plane)
PSIWTE(I)	trailing-edge sweep of wing section to the right of the I^{th} trailing leg, degrees; positive swept back (measured in wing planform plane)
PHID(I)	dihedral angle of wing section to the right of the I^{th} trailing leg, degrees; positive up

Based on these input data, the wing is divided chordwise and spanwise into trapezoidal shaped elemental panels and one horseshoe vortex placed on each panel. All the NCW panels in a chordwise row have equal chords and spans, the spans being determined by the Y(I)'s. The horseshoe vortex is made up of three vortex lines; a bound vortex which is swept to coincide with the quarter chord of the panel and two trailing vortex legs which lie along the edges of the panel and extend to infinity behind the wing.

The question arises as to the values to use for NCW and MSW. This is discussed to some extent in section 4.3.2 of reference 2 where it is shown that as the vertical distance from the wing to the points at which the velocity field is to be calculated decreases additional chordwise vortices must be added in order to accurately calculate the velocities. A procedure which can be used is to locate the initial position of the axis of the store whose trajectory is to be calculated relative to the wing in terms of a fraction of the local wing chord, that is, the chord immediately above the store, and use the following table.

z/c	NCW
0.10	10
.15	8
.20	6
.25	4

The number of vortices in a spanwise row is controlled to some extent by the wing. A vortex trailing leg must coincide with the root chord and each break in leading-edge sweep angle, trailing-edge sweep angle, and dihedral angle, and if a pylon is present, a trailing leg must coincide with the spanwise location of the pylon. One must also coincide with the wing tip. Consider the example wing of figure 14. There is a break in trailing-edge sweep at $y_w/s = -0.2$, a break in leading-edge sweep at -0.4, a pylon at -0.6, and a break in dihedral at -0.7. To place a trailing leg at each of these positions plus the wing tip and the root chord requires five vortices across the semispan. This is the minimum number which can be used for this wing and may or may not be sufficient. Experience with the program has shown that in some cases five vortices in a spanwise row has given good results.

The only sure way of determining convergence with number of vortices, both NCW and MSW, is to examine the results obtained from the trajectory program. One of the quantities output by the program is the normal-force distribution on the separated store. If this distribution is smooth then sufficient vortices are probably being used. If not, NCW and possibly MSW should be increased. For a particular wing various vortex layouts should be tried to assure convergence. The minimum number of vortices, consistent with the desired accuracy, should be used in order to minimize the trajectory calculation time.

The maximum number of vortices that can be placed on the left wing panel and pylon is 100. This limit is imposed by dimension statements in the computer program.

Item number 12 consists of a deck of MSW+1 cards. The index I is the vortex trailing leg number. The trailing legs are numbered from the root chord, I = 1, to the tip, I = MSW + 1. Associated with each I are the spanwise location of the trailing leg, Y(I), the sweep angles of the leading and trailing edges of the wing segment to the right of the trailing leg, PSIWLE(I) and PSIWTE(I), and the dihedral angle of the section to the right, PHID(I). When I = 1 all of these quantities are zero. Note that the sweep angles are measured in the wing planform plane.

The two indices of item number 13 are associated with the wing twist and camber distribution.

NTAC — twist and/or camber? NTAC = 0, no; NTAC = 1, yes

NUNI — if wing has no twist, and the camber distribution is similar at all spanwise stations, NUNI = 1; for all other cases, NUNI = 0 (omit if NTAC = 0)

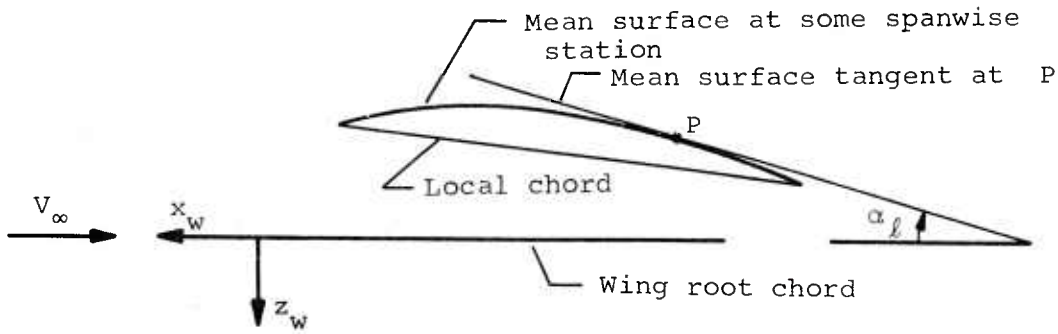
If NTAC = 1, item number 14 is included in the input data deck. These data specify the wing twist and/or camber distribution in terms of the tangent of the local angle of attack of the camberline for a wing root-chord angle of attack of zero degrees. The function of the index NUNI is explained below

ALPHAL(J) — $\tan \alpha_\ell$ of the wing camberline at the vortex lattice control points. If NUNI = 1 only data for the chordwise row adjacent to the root chord are input. The first value is for the control point nearest the leading

edge. If NUNI = 0, data for all chordwise rows must be input starting nearest the root chord and working outboard. Data for each row start on a new card (omit if NTAC = 0)

The vortex lattice control points are at the midspan of the three-quarter chord line of each elemental panel laid out by NCW, MSW, and the Y(I)'s of items 11 and 12.

The values of ALPHAL(J) are obtained as follows. Consider the following sketch



which shows the cambered and twisted section of the lifting surface at some spanwise station for zero wing angle of attack. At the control point P, a tangent to the surface is constructed, which makes an angle α_ℓ with the root chord (the x_w axis). The positive sense of α_ℓ is shown. The input value required is ALPHAL(J) = tan α_ℓ. For wings which have the same camber distribution at all spanwise stations and no twist, NUNI = 1, data are only input for the row of control points closest to the root chord. The program assigns these values to all other rows.

The two indices of item number 15 are associated with the specification of the wing thickness distribution. They are

NCWS — number of thickness panels in a chordwise row on the wing; (NCWS*MSW) $\leq$ 400

NUNIS — if wing has a similar thickness distribution at all spanwise stations, NUNIS = 1; if not, NUNIS = 0

The thickness panels are also trapezoidal in shape. The span of each chordwise strip is the same as the corresponding row of horseshoe vortices. Each of these chordwise strips is divided into NCWS equal chord panels.

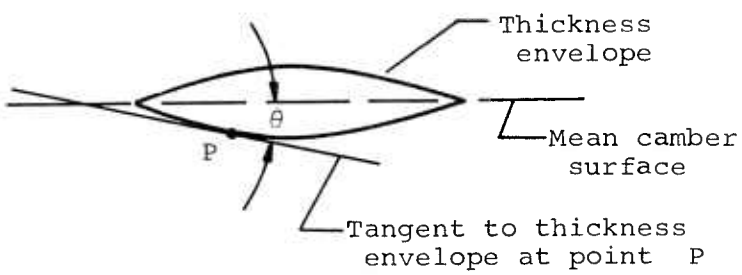
Considerably more thickness panels should be used in a chordwise row than were vortices. Experience with the program has shown 16 to 20 thickness panels usually to be sufficient. Again, this can only be checked by varying the number and examining the resulting store load distributions and the minimum number, consistent with the desired accuracy, should be used to minimize the trajectory calculation time.

The data contained in item number 16 are

THETAL(J) slope of the wing thickness distribution at the centers of the thickness panels. If NUNIS = 1 only data for the chordwise row adjacent to the root chord are input. The first value is for the panel at the leading edge. If NUNIS = 0, data for all chordwise rows must be input starting at the root chord and working outboard. Data for each row start on a new card.

Note that the values of the thickness slopes are input for the center of each panel, that is, the midspan of the 50-percent chord. Also, for wings with similar distributions at all spanwise station, NUNIS = 1, data are only input for the row of panels adjacent to the root chord. The program assigns these values to all other rows.

The values of THETAL(J) are obtained as follows. Consider the following sketch



which shows the thickness envelope at a spanwise station where the slopes are to be determined. At a point P at which the slope is required, a tangent to the surface of the thickness envelope is constructed which makes an angle θ with the line connecting the leading and trailing edges of the envelope. The input value required is THETAL(J) = tan θ. Forward of the point of maximum thickness θ is positive and aft of this point it is negative.

The next five items of input data, items 17 through 21, are associated with the pylon if one is present, NPY = 1. Item number 17 consists of one card and contains the following quantities

IP — index of the y_w location of the pylon. This must be one of the Y(I)'s read in for the wing vortex lattice

PSIPLE — sweep angle of the pylon leading edge in the wing coordinate system, degrees. Positive sweep is swept back.

PSIPTE — sweep angle of the pylon trailing edge in the wing coordinate system, degrees. Positive sweep is swept back.

CRP — length of pylon root chord, feet

H — height of pylon measured from wing chordal plane, feet

XPLE — location of pylon root chord leading edge measured from local wing chord leading edge, feet (negative behind)

The pylon location can be under the fuselage, IP = 1, or at one of the wing vortex trailing leg locations outboard of the wing fuselage juncture. The remaining five items are shown in figure 15 for the two cases.

The next two items of input data are associated with the vortex lattice which represents the pylon loading. Item number 18 is one card and contains

NCP — number of vortices in a chordwise row on the pylon; (NCP*MSP) $\leq$ 30

MSP — number of vortices in a spanwise row on pylon; also number of thickness strips in a spanwise row on the pylon; MSP $\leq$ 4

For a typical pylon, two or three vortices in a spanwise row are sufficient, MSP = 2 or 3. The number chordwise, NCP, depends on the length of the pylon root chord. The chordwise dimensions of the trapezoidal shaped area elements on the pylon should be approximately the same as those on the wing immediately above the pylon. That is, the local wing chord length divided by NCW of item 11 should be approximately equal to the pylon root chord length divided by NCP.

The program is limited to 100 vortices on the wing-pylon combination. Thus

$$NCW*MSW + NCP*MSP \leq 100$$

Item number 19 consists of a deck of MSP+1 cards which contain the following information

K	pylon vortex trailing leg number; K = 1 to MSP+1
Z(K)	z location of the K^{th} trailing leg, feet; measured from local wing chord

The first trailing leg should be placed on the pylon root chord and the last on the tip chord. The remaining trailing legs should be equally spaced between these two. For a pylon located under the fuselage, figure 15(a), Z(1) should be the z_w location of the pylon root chord, the bottom of the fuselage, and Z(MSP+1) should equal Z(1) + H. For a pylon under the wing, Z(1) = 0 and Z(MSP+1) = H.

Items 20 and 21 provide data required in order to model the pylon thickness distribution. The data are

NCPS	number of thickness panels in a chordwise row on the pylon; (NCPS*MSP) $\leq$ 180
NUNIP	if pylon has a similar thickness distribution at all spanwise stations, NUNIP = 1; if not, NUNIP = 0
THETPL(J)	slope of the pylon thickness distribution at the centers of the thickness panels. If NUNIP = 1 only data for the chordwise row adjacent to the root chord are input. The first value is for the panel at the leading edge. If NUNIP = 0, data for all chordwise rows must be input starting at the root chord and working outboard. Data for each row start on a new card.

These data are prepared in the same manner as were the corresponding data for the wing thickness, items 15 and 16.

The next four items of input data locate and describe the ejection rack if one is present, NRACK of item 4 is equal to one. If NRACK = 0 these four items are bypassed. If a rack is present the preceding data for the pylon must have been input since the program has been written assuming that if there is a rack there also is a pylon. The rack data to be input only model the body of the rack. No provision has been made in the program for modeling the short pylons on which the stores are mounted.

Item number 22 is one card and contains the following information

RLTHC — length of rack, feet

RRMAX — maximum rack radius, feet

XRNC — x_ℓ location of rack nose measured from local wing chord leading edge, feet; positive ahead

ZRN — z_ℓ location of rack nose measured from local wing chord leading edge, feet; positive below

RIC — rack incidence angle measured relative to wing root chord, degrees; positive nose up

Items number 23, 24, and 25 are data specifying the source distribution for the equivalent incompressible rack as calculated by the source distribution program.

NRSOR — number of rack sources; NRSOR $\leq$ 100

RXL(J) — incompressible (x/ℓ)'s of the rack sources

RSOR(J) — incompressible dimensionless rack source strengths

Item number 23, NRSOR, specifies the number of sources. This number is printed at the top of page 3 of the source distribution output, see for example figure 9(c). Item 24, the RXL array, and item 25, the RSOR array, are the locations, x/ℓ, and the dimensionless strengths, Q*, of the NRSOR sources, respectively. These quantities are also printed on page 3 of the source distribution program output, see for example figure 9(c). Item 24 contains all of the x/ℓ's punched six to a card except for the last card which will contain less if NRSOR is not a multiple of 6. Item 25 begins on a new card and contains the Q*'s.

If no stores are present, NSTRS of item 4 is equal to zero, this concludes the input data deck. If NSTRS is not zero, then the next five items of input data describe all stores present on the aircraft including the store to be separated. The store to be separated must be under the fuselage centerline or to the left of this line as seen by the pilot. Data should be input for all stores which are close enough to affect the trajectory including those under the right wing panel.

Item number 26 is a deck of NSTRS cards which contain the following information.

NUMSTR(J)	store number; different for each store and $\leq$ 99
NSHAPE(J)	shape number of store; $\leq$ 99
SLTHC(J)	length of store, feet
SRMAX(J)	maximum radius of store, feet
XSNC(J)	x_ℓ location of store nose measured from wing chord leading edge immediately above store, feet; positive ahead
YSN(J)	y_w location of store nose measured from wing root chord, feet; positive to the right
ZSN(J)	z_ℓ location of store nose measured from wing chord leading edge immediately above store, feet; positive below
SIC(J)	store incidence angle measured relative to wing root chord, degrees; positive nose up

The numbers of the stores do not have to be consecutive and can have any value from 1 to 99. The same applies to the shape numbers except that more than one store can have the same shape number. For example, for a MER grouping of six identical stores, different store numbers would be assigned to each store but they would all have the same shape number.

Item number 27 is one card which contains

NSHPT	total number of shapes for which store source distributions are to be input; equal to the number of different values of NSHAPE(J)

Items 28, 29, and 30 are the source distribution data for a particular store shape. These three items are repeated in sequence for each different shape. The data are

MSHAPE	shape number of store represented by the following source distribution; equal to one of the values of NSHAPE(J)
MSOR	number of sources for this store shape; MSOR $\leq$ 100
DUMX(J)	incompressible (x/ℓ)'s of the store sources
DUMQ(J)	incompressible dimensionless store source strengths

The quantity MSHAPE must have the same value as one of the shape numbers read into the NSHAPE(J) array, item 26. The remaining quantities specify the source distribution for the equivalent incompressible store as calculated by the source distribution program. The quantity MSOR specifies the number of sources. This number is printed at the top of page 3 of the source distribution output, see for example figure 6(c). Item 29, the DUMX array, and item 30, the DUMQ array, are the locations, x/ℓ, and the dimensionless strengths, Q*, of the MSOR sources, respectively. These quantities are also printed on page 3 of the source distribution program output, see for example figure 6(c). Item 29 contains all of the x/ℓ's punched six to a card except for the last card which will contain less if MSOR is not a multiple of 6. Item 30 begins on a new card and contains the Q*'s. The quantity MSOR and the DUMX and DUMQ arrays are temporary storage for the source distribution. Immediately after reading in all data for one distribution these data are transferred to other arrays for each store with this shape.

The remainder of the input data deck is additional data required to describe the store being separated and other data required for the force and moment and trajectory calculations.

Item number 31 is one card which contains eight indices. They are

NEJECT	number of the store being separated
NSEG	number of equal length segments the body is to be broken into for the force calculation; NSEG $\leq$ 40
NSEGXO	number of body segments to the flow separation location
NGAM	trajectory to simulate wind-tunnel captive-store trajectory? NGAM = 0, no NGAM = 1, yes
NPOLY	number of polynomials specifying store shape; $1 \leq$ NPOLY ≤ 7
NROLL	rolling moment to be calculated? NROLL = 0, no NROLL = 1, yes
NEMP	empennage present? NEMP = 0, no NEMP = 1, yes
NDAMP	damping to be included in force calculation? NDAMP = 0, no NDAMP = 1, yes

The index NEJECT must be one of the store numbers that was read into the NUMSTR array through item 26.

In the store body force and moment calculation, the body is divided into NSEG equal length segments. Experience in using the program has shown that 20 body segments, NSEG = 20, usually yields sufficiently accurate forces and moments. This can only be checked for a specific case by varying NSEG and comparing results. To minimize calculation time NSEG should be kept as small as possible.

No definite rules for the selection of a value of NSEGXO can be given. For stores with cylindrical afterbodies NSEGXO should probably be input as NSEG. For stores with boattailed afterbodies NSEGXO should probably be less than NSEG. A further discussion is given in sections 6.2 and 8.2 of reference 2. In that discussion the work of Hopkins (ref. 3) is mentioned. In this work he correlated, for bodies of revolution in uniform flow, the maximum extent of applicability of potential flow as a function of the location of the maximum negative rate of change of body cross-sectional area. From that reference

$$\frac{x_o}{\ell} = 0.378 + 0.527 \frac{x_1}{\ell}$$

where x_o/ℓ is the location on the body where potential flow is no longer applicable and viscous forces are important and x_1/ℓ is the location on the body of the maximum negative rate of change of cross-sectional area (ℓ is the body length). Whether or not this correlation applies to non-uniform flow is not known but it can be used in estimating the value of NSEGXO.

The index NGAM is included as input solely for the purpose of allowing the program to be used to compare with captive store data obtained in the wind tunnel. Since the wind tunnel cannot produce a flow where the store sees a free-stream velocity coming from a different direction than that seen by the parent aircraft the captive store case must be handled differently by the computer program.

The number of polynomials specifying the store shape, NPOLY, is the number required to specify the shape from the store nose to its base. These polynomials are used in the force and moment calculation and, hence, do not have to model the wake in the manner done in the source distribution

calculation. The polynomials are of the same form, however, and are given by equation (1).

The next index, NROLL, indicates whether or not the rolling moment for a store with an empennage is to be calculated. NEMP specifies whether there is an empennage. The last index, NDAMP, is used by the program to determine whether or not aerodynamic damping in pitch, yaw, and roll is to be included in the force and moment calculation.

Item number 32 is one card and specifies the store mass and inertia characteristics. The quantities are

SMASS		store mass, slugs
FIXX	I_{xx}	moment of inertia, slug-ft^2
FIYY	I_{yy}	moment of inertia, slug-ft^2
FIZZ	I_{zz}	moment of inertia, slug-ft^2
FIYZ	I_{yz}	product of inertia, slug-ft^2
FIXZ	I_{xz}	product of inertia, slug-ft^2
FIXY	I_{xy}	product of inertia, slug-ft^2

The equations defining the moments and products of inertia are given by equation (II-36) of Appendix II of reference 1.

The one card of item number 33 contains

XMOM	location along store axis about which the pitching and yawing moments are to be taken, negative behind nose, feet; same point about which moments of inertia are taken
XBAR	x location of store c.g. measured from moment center, feet; positive forward
YBAR	y location of store c.g. measured from store axis, feet; positive to the right
ZBAR	z location of store c.g. measured from store axis, feet; positive below

The next two items of input, items 34 and 35 describe the shape of the ejected store. The quantities contained on the cards are

XEND(J)	x/ℓ of end points of polynomials specifying shape of ejected store, NPOLY values
COEF(J,K)	coefficients of polynomials specifying shape

These data are the same data input as items 4 and 5 to the source distribution, see figure 3, with one exception. This exception is that the shape is only required in the range $0 \leq x/\ell \leq 1$ since no load is carried by the wake which was modeled in obtaining the source distribution. The preparation of these data is described in section 3.2.1.

Item number 36 contains two quantities which are

CA — store axial-force coefficient; reference area is store maximum cross-sectional area

CDC — crossflow-drag coefficient

The store axial-force coefficient is not calculated by the computer program so it is required input. The crossflow-drag coefficient is used in the viscous crossflow force and moment calculation which is used in place of the slender-body calculation behind the assumed separation location. It is defined as the section drag coefficient of a circular cylinder normal to the airstream. That is,

$$\text{CDC} = c_{d_c} = \frac{\text{drag per unit length}}{q_\infty (2r)}$$

where q_∞ is the free-stream dynamic pressure and r is the cylinder radius. The value commonly used for this parameter is 1.2.

The next two items of input data are included in the input data deck if an empennage is present, NEMP = 1 in item 31. Item 37 contains

IPLNR — IPLNR = 0, cruciform empennage
IPLNR = 1, planar empennage

MSF — number of spanwise control points on each fin; must be odd and $5 \leq \text{MSF} \leq 11$.

It should be noted that MSF must be odd and in the range $5 \leq \text{MSF} \leq 11$. For the store shown in figure 5(d) MSF = 5 has been found to give accurate results. The larger the fin span to body radius ratio, the more points required.

The next card, item number 38, contains

XTAIL — x location at which empennage forces are to act measured from store nose, feet; negative number

RADAV — average store body radius in empennage region, feet; positive number

FINSS	tail fin semispan, measured from body longitudinal axis, feet; positive number
PHIROL	initial fin orientation, degrees; $0 \leq$ PHIROL ≤ 90; PHIROL = 0 if fins vertical and horizontal
CLALPH	lift-curve slope of two exposed panels joined together, per radian; reference area is store maximum cross-sectional area

The location at which the empennage forces are assumed to act, XTAIL, is arbitrary. A good position to use is the quarter chord of the mean aerodynamic chord of the exposed panels. The lift-curve slope, CLALPH, can be estimated using reference 4.

Item number 39 is one card which contains the initial velocities of the store relative to the parent aircraft such as might exist at the end of the ejection stroke of a store released from a pylon or rack. The two quantities are

VZERO	store downward ejection velocity perpendicular to store longitudinal axis, ft/sec
VAR(5)	store initial pitching rate, q, radians/sec

At the beginning of the trajectory, the end of the stroke, the store is oriented such that its y-axis is parallel to the y_B fuselage axis shown in figure 13. Thus the x,z store plane is parallel to the x_B, z_B fuselage plane and the initial translational velocity of the store, VZERO, is in the x,z store plane perpendicular to the store x-axis. The initial pitching rate of the store, q or VAR(5), is about the store y-axis positive nose up.

The next card, item number 40, contains three times. They are

DTIME	integration interval, seconds
TIMEI	initial time, seconds
TIMEF	final time, seconds

The first, DTIME, is an initial guess at the integration interval to be used in the integration subroutine. Experience in using the program has shown that 0.05 or 0.10 seconds is a good value to use. The initial time, TIMEI, must be input as 0.0 unless a trajectory is to be restarted using the last page of output from a previous run to obtain the initial conditions. Then, TIMEI should be given the value that appears on that page of output.

The final time, TIMEF, is the time from ejection at which the trajectory calculation is to be terminated. Except for very unusual trajectories, a value of 0.5 to 0.7 seconds is normally sufficient for the store to clear the aircraft.

If TIMEI and TIMEF are both input as zero, no trajectory calculation will be performed. However, the store load distributions and forces and moments will be calculated with the store in its initial position. This feature can be useful in checking out the entire input data deck prior to running a trajectory or for studying store loadings at specific points.

The last item of input, item number 41, is input only if a trajectory is being restarted, TIMEI $\neq$ 0. This item consists of two cards with VAR(1) through VAR(8) on the first card and VAR(9) through VAR(12) on the second. The following table gives the notation used to identify VAR(1) through VAR(12) on the trajectory program output which will be discussed in section 4.3.

Program Notation	Output Notation
VAR(1)	DXF, ft/sec
VAR(2)	DYF, ft/sec
VAR(3)	DZF, ft/sec
VAR(4)	P, radians/sec
VAR(5)	Q, radians/sec
VAR(6)	R, radians/sec
VAR(7)	XF of XMOM, ft.
VAR(8)	YF of XMOM, ft.
VAR(9)	ZF of XMOM, ft.
VAR(10)	PSI, degrees
VAR(11)	THETA, degrees
VAR(12)	PHI, degrees

4.2.2 Sample input data

Sample input data decks for two cases will now be presented. Both cases will utilize the wind-tunnel model components shown in figure 5 except that they have been scaled up by a factor of twenty in order to approximate a full-scale aircraft and stores.

The configuration for the first example is shown in figure 16. It consists of the wing-fuselage combination shown in figure 5(a) with the pylon of figure 5(b) at the one-third semispan position of the left wing panel. The store being ejected is below this pylon and is that shown in figure 5(d). Its initial position is one radius below the carriage position. The cruciform fins are rolled 45° from the vertical and horizontal. Grouped under the fuselage are three of the stores shown in figure 5(e). They are positioned as they would be if the pylon and rack shown in figures 5(b) and 5(c) were present. The store which may exist under the right wing panel has not been included since it is so far removed from the store being ejected that it would not influence the trajectory.

The input data deck for this case is tabulated in figure 17. The item numbers indicated on the figure correspond to those of figure 12. The first item on figure 17 is item number 1 which contains the value of NCARDS, in this case 13. This is followed by item number 2, which consists of these 13 cards of identifying information.

Item number 3 specifies the aircraft flight conditions. The angle of attack is 4.0 degrees, the flight path angle is 0.0 degrees, and the Mach number is 0.4. The free-stream air density is 0.0020482 slugs per cubic foot which corresponds to a flight altitude of 5,000 feet. The flight velocity is 440.7 feet per second.

The aircraft components which are present are specified by item 4. There is a fuselage; there is a pylon; there is no rack; and there are 4 stores.

Items 5 through 8 are the fuselage input data. Item 5 contains the fuselage length and maximum radius as shown in figure 16. Items 6, 7, and 8 contain the source distribution representing the fuselage volume. These data were obtained from figure 7(c).

The next seven items are the wing input data. Item 9 gives the position of the wing root chord leading edge and wing incidence relative to the fuselage and item 10 specifies the root chord length and the semispan. These quantities are shown in figure 16. Items 11 and 12 are data required by the program to lay out the vortex lattice. There are to be 8 vortices in each chordwise row and 5 of these rows across the semispan.

This requires that the spanwise locations on the left wing panel of six trailing legs and the sweep and dihedral angles to the right of these points be specified. These data are contained on the six cards of item 12. Note that one trailing leg coincides with the pylon location, y = -6.66667. Item 13 indicates that the wing has neither twist nor camber, and thus item 14 of figure 12 is omitted from the input data deck. Items 15 and 16 specify the wing thickness distribution. The two indices on item 15 indicate that 16 thickness panels are to be placed in a chordwise row and that the wing has a similar thickness distribution at all spanwise stations. Consequently, item 16 consists of two cards with the 16 values of the slope of the thickness distribution. The airfoil section specification is shown in figure 5(a).

Since there is a pylon, items 17 through 21 are input and contain the pylon data. The pylon is the one shown in figure 5(b), except that it has been scaled up by a factor of 20. Item 17 of the input data specifies that the pylon is located below vortex trailing leg number 3, the leading- and trailing-edge sweep angles are 0.0 degrees, the root chord length is 3.33333 feet, the height is 1.652 feet, and the leading edge is 3.046 feet behind the local wing chord leading edge (see fig. 16). Items 18 and 19 are the pylon vortex lattice data. There are to be two vortices in a chordwise row and two of these rows spanwise. The three trailing leg locations are given by item 19. Items 20 and 21 specify the pylon thickness distribution. There are to be 60 thickness panels in a chordwise row and the thickness distribution is similar at all spanwise stations. The large number of panels chordwise is necessitated by the thickness distribution of the pylon shown in figure 5(b). Since the pylon is a flat plate with a radius on the leading and trailing edges, a large number of panels is required if any leading-edge and trailing-edge detail is to be included. This is shown by the thickness envelope slope data of item 21. Sixty equal chord panels in a chordwise row only places four panels on each of the two radii.

Since there is no ejection rack in the case shown in figure 16, items 22 through 25 are omitted from the input data deck.

Item 26 begins the store data. One card is input for each store shown in figure 16. The wing store is assigned store number 10 and the TER group 20, 21, and 22, 20 being the bottom store, 21 the left shoulder

store, and 22 the right shoulder store. The wing store is assigned shape number 2 and the TER stores, shape number 5. With the exception of the incidence angle of the stores, which is 0.0, the information required to prepare the remaining data in item 26 are shown in figure 16. The trajectory to be calculated is for the wing store and is to be started with the store one radius below the carriage position. The data for this store locate it in this position. Since two different shape numbers were assigned in item 26, two different source distributions are to be input. This is indicated in item 27. Items 28, 29, and 30, which are the source distributions, are input twice. The first set of data is for shape 2 and is obtained from the source distribution program output which was presented in figure 6(c). The data for shape 5 are from figure 8(c).

Item 31 contains eight indices which indicate the following. Store number 10, NEJECT = 10, is the store being separated and the body is to be broken into 20 segments, NSEG = 20, for the force and moment calculation with flow separation occurring at the base of the store, NSEGXO = 20. In addition, a free-flight trajectory is to be calculated, NGAM = 0; two polynomials are to be input describing the body shape, NPOLY = 2; rolling moment is to be calculated, NROLL = 1; the store has an empennage, NEMP = 1; and aerodynamic damping is to be included, NDAMP = 1.

Item 32 contains the mass and inertia characteristics of the separated store. The particular numbers used in this example have been assigned and have not been determined by specifying a density distribution of the store and performing the required integrations. Item 33 specifies that the inertia characteristics are assumed to have been calculated about a point 5.3125 feet behind the store nose and that the store center of gravity is not offset from this point.

Items 34 and 35 contain the end points and coefficients of the polynomials describing the store shape. These data are the same as those used in the source distribution calculation for this shape except that a polynomial for the wake is not required since the load distributions are not calculated on the wake. The last end point could have been 1.0 rather than 1.1 as shown.

The store axial force coefficient, 0.4, and crossflow drag coefficient, 0.0, are input in item 36. A crossflow drag coefficient is not used in this example since flow separation is not assumed to occur ahead of the store base.

Items 37 and 38 are data describing the store empennage. Item 37 specifies a cruciform empennage and five control points on each tail panel. Item 38 indicates that the empennage forces act 9.376 feet behind the store nose, the body radius in the fin region is 0.625 feet, the fin semispan is 1.45833 feet, the initial fin orientation is 45° from the vertical and horizontal, and the lift-curve slope is 3.22. The fin details are obtained from figure 5(d) and scaled up by a factor of 20.

Item 39 specifies an initial downward translational velocity of the store of 10 feet per second and an initial pitching rate velocity of 0.0.

The last card of input, item 40, provides a guess at the integration interval and the initial and final times. Since the initial time is 0.0, item 41 is not included.

Input data have been prepared for a second sample trajectory calculation. The configuration is shown in figure 18. It is made up of the model components shown in figure 5 which again have been scaled up by a factor of 20. In this case there is a pylon with a TER under the fuselage centerline. The bottom store on the rack is being ejected with its initial position one radius below the carriage position. In this case there is a store under each wing panel since they will each have an equal effect on the trajectory.

The input data deck for this case is listed in figure 19. An item-by-item description of this deck will not be given. With the detailed description which was given for the deck of figure 17, the program user should be able to understand the preparation of the deck of figure 19. The major differences are

(1) The pylon is under the fuselage.
(2) There is a TER on the pylon.
(3) There is a store under the right wing panel.
(4) The separated store does not have an empennage.

4.3 Output from the Program

4.3.1 Sample trajectory - case 1

Figure 20 presents the output from the trajectory program for sample case 1, the configuration of figure 16, and the data deck of figure 17.

The first three pages of output are self-explanatory since they tabulate input data for the flight conditions, fuselage, wing, and pylon. The fourth page of output, figure 20(d), tabulates the coordinates of the wing and pylon vortex-lattice control points along with the input values of the slope of the wing camberline at these points. The x,y,z coordinates are in the wing coordinate system, see figure 14, whose origin is at the leading edge of the wing root chord. These points are in the wing chordal plane. Thus, for wings with dihedral, the z-coordinate will not be zero. The next page of output, figure 20(e), tabulates the input values of the slopes of the thickness distribution for all chordwise rows on both the wing and pylon. Figure 20(f) lists the input data describing the four stores present.

Page 7 of the output, figure 20(g), is another page of output pertaining to the wing-pylon vortex lattice. The x,y,z coordinates are the same as those tabulated in figure 20(d). The next three columns, U/VINF, V/VINF, and W/VINF, are the sums of the dimensionless perturbation velocities in the x, y, and z directions, respectively, induced at the control points by all of the other aircraft components. These include fuselage, rack, and stores as well as wing thickness on pylon and pylon thickness on wing. VINF is the free-stream velocity. The last column tabulates the strengths of the horseshoe vortices divided by the free-stream velocity, GAMMA/VINF, which were determined by solving the set of simultaneous equations given by equation (6) and (7) of reference 1.

Page 8 of the output, figure 20(h), indicates the number of the store separated and tabulates the additional data which were read in to describe this store.

The last three parts of figure 20, parts i, j, and k, are output for three points in the trajectory, the first point, an intermediate point, and the point at which the trajectory is terminated. The complete output from the program will contain a page like this for each integration step, in this case every 0.05 seconds.

At the top of each page is the trajectory time in seconds. Following this, the forces and moments are tabulated, components as well as totals, and then the body load distributions and the velocity distributions along the store axis from which these load distributions were calculated. The load distributions are the sums of those due to buoyancy, slender body, and viscous crossflow. The velocity field calculation is discussed in detail in section 5.1 of reference 1 and the force and moment calculation in sections 5.2 and 5.3.

The following table relates the program output variables to the x_s, y_s,z_s coordinate system and positive directions shown in figure 21.

Program Notation	Notation of Figure 21
CN	C_N
CY	C_Y
CLM	C_m
CLN	C_n
CLL	C_ℓ
X, FT	x_s, feet
X/L	x_s/ℓ_s
DCN/DX	dC_N/dx_s, per foot
DCY/DX	dC_Y/dx_s, per foot
U/VS	U_s/V_{∞_s}
V/VS	V_s/V_{∞_s}
W/VS	W_s/V_{∞_s}

As the store pitches, yaws, and rolls during the trajectory, the x_s,y_s,z_s coordinate system pitches, yaws, and rolls with it. The velocities and forces are always calculated in this coordinate system.

The remaining quantities tabulated on each page of trajectory output specify the store location, orientation, velocities, and accelerations relative to the parent aircraft at that particular time. Before discussing these quantities, the coordinate systems must be mentioned. Figure 21 shows another coordinate system, x, y, and z, which is fixed in the store

and moves with the store as it yaws, pitches, and rolls. The origin of this system is fixed at the store moment center. This coordinate system is also shown in figure 22 along with another system, ξ,η,ζ. This latter system is an inertial coordinate system whose origin is fixed in the fuselage nose and is parallel to the x_B,y_B,z_B system of figure 13. At any point in time, the two coordinate systems are orientated with respect to each other by a system of angles. The system of angles are those shown in figure 22 and consist of three rotations in the yaw, Ψ, pitch, Θ, and roll, Φ sequence. The positive sense of the three store rotational velocities about the x,y,z axes are also shown in the figure.

Following the load and velocity distribution output on, for example, figure 20(j), the location of the store in the fuselage, or inertial, coordinate system is tabulated. The location of the store nose, NOSE, moment center, XMOM, and base, BASE, are tabulated relative to the fuselage nose and also relative to the position of the store at time $t = 0$. In this tabulation XF is x_B of figure 13 or ξ of figure 22. Likewise, YF is y_B or η and ZF is z_B or ζ.

The next output are the translational velocities and accelerations of the store relative to the moving aircraft. For example,

$$\text{DXF} = \frac{dx_B}{dt} \text{ or } \frac{d\xi}{dt}, \text{ ft/sec}$$

$$\text{D2XF} = \frac{d^2x_B}{dt^2} \text{ or } \frac{d^2\xi}{dt^2}, \text{ ft/sec}^2$$

Next the rotational velocities shown in figure 22 are listed as are the rotational accelerations. The notation is

$$\text{P} = p, \text{ radians/sec}$$

$$\text{Q} = q, \text{ radians/sec}$$

$$\text{R} = r, \text{ radians/sec}$$

$$\text{PDOT} = \frac{dp}{dt}, \text{ radians/sec}^2$$

$$\text{QDOT} = \frac{dq}{dt}, \text{ radians/sec}^2$$

$$\text{RDOT} = \frac{dr}{dt}, \text{ radians/sec}^2$$

The last output printed at each integration step are the values of the three orientation angles shown in figure 22 and their time rates of change. The notation is

$$\text{PSI} = \Psi, \text{ deg.}$$

$$\text{THETA} = \Theta, \text{ deg.}$$

$$\text{PHI} = \Phi, \text{ deg.}$$

$$\text{DPSI} = \frac{d\Psi}{dt}, \text{ radians/sec}$$

$$\text{DTHETA} = \frac{d\Theta}{dt}, \text{ radians/sec}$$

$$\text{DPHI} = \frac{d\Phi}{dt}, \text{ radians/sec}$$

4.3.2 Sample trajectory - case 2

The output for the second sample trajectory are presented in figure 22. This case was shown in figure 18 with the input data deck listed in figure 19. The output is basically in the same format as that shown in figure 20 for case 1 with one exception. An additional page of output is printed which tabulates the rack input data.

5. PROGRAM RUNNING TIMES

The programs described in this report have been run on both the Univac 1108 and the CDC 6600. Because of machine differences, the running times vary from one machine to the other. As a consequence, only an approximate running time for each of the two programs can be given. On any machine comparable to the previously mentioned, the source distribution program should take 3 to 5 seconds per distribution.

The running time of the trajectory program is a function of a number of additional factors, some of which are

(a) Number of sources required to represent the bodies
(b) Number of stores present
(c) Number of vortices used in vorticity distribution
(d) Number of thickness panels on wing and pylon
(e) Number of body segments and tail fin control points used in force and moment calculation

(f) Integration interval

(g) Real time duration of trajectory

With the exception of (f) above, all of the other things should be kept to a minimum. The integration routine used in the program selects the integration interval to be used based on accuracy requirements which are incorporated in the program. In arriving at this interval, it uses the guess which was input. For the program to run with the largest interval, too large a guess is better than too small. For the two sample trajectories which were presented, the running times were 2 to 3 minutes on the CDC 6600 and 7 to 8 minutes on the Univac 1108.

TABLE I

SMALL BOATTAIL STORE COORDINATES

Station, inches	Radius, inches
0	0
0.112	0.067
0.212	0.108
0.312	0.139
0.412	0.161
0.512	0.180
0.612	0.195
0.712	0.209
0.812	0.222
0.912	0.232
1.012	0.241
1.112	0.248
1.212	0.254
1.312	0.258
1.412	0.262
1.512	0.265
1.612	0.266
1.712	0.267
1.812	0.267
1.912	0.268
2.312	0.268
2.412	0.266
2.512	0.264
2.612	0.259
2.712	0.254
2.812	0.248
2.912	0.241
3.012	0.234
3.173	0.222
3.812	0.175
4.430	0.175

TABLE II

SUBROUTINES USED IN SIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM

Subroutine Name	Function
ADAMS	Numerical integration routine to integrate differential equations
CEL1	Calculates complete elliptic integral of the first kind
CEL2	Calculates complete elliptic integral of the second kind
DIRCOS	Calculates direction cosines between inertial and store body coordinate systems
ELI1	Calculates generalized elliptic integral of the first kind
ELI2	Calculates generalized elliptic integral of the second kind
EMPFOR	Calculates store empennage forces and moments
EMPINI	Initializes for empennage force and moment calculation
FORCE	Calculates the store-body forces and moments
INFWW	Calculates velocities induced at a field point by a horseshoe vortex
INTOST	Transforms a vector with components in the inertial coordinate system to one with component in the store body coordinate system
INVERS	Solves a system of simultaneous linear algebraic equations
OUTPUT	Prints forces, moments, load distributions, and trajectory data at the end of each integration step
PTHIN	Reads in pylon thickness data and lays out thickness strips
PVLIN	Reads in pylon vortex-lattice data and lays out vortices
SHAPE	Calculates radius and surface slope at a point on separated store from input polynomials
SIMSON	Performs a Simpson rule integration

TABLE II (conc.)

Subroutine Name	Function
SOROUT	Prints an input source distribution
STRIO	Reads in and prints out data for all stores present
STTOIN	Transforms a vector with components in the store body coordinate system to one with components in the inertial coordinate system
THOUT	Prints wing and pylon surface slopes
THPVEL	Calculates velocities induced at a field point by the pylon thickness distribution
THWVEL	Calculate velocities induced at a field point by the wing thickness distribution
VELFLD	Calculates velocities induced at a field point by all aircraft components
VELOC	Calculates velocities at a field point of an axisymmetric body
VLCOEF	Calculates coefficient matrix of set of equations to be solved for wing-pylon vorticity distribution
VLIVEL	Calculates velocities induced at a field point by wing-pylon vorticity distribution and calls THWVEL and THPVEL
VLOUT	Prints vortex lattice control point coordinates and input twist and camber distribution
VLRHS	Calculates right-hand side of set of equations to be solved for wing-pylon vorticity distribution
VSTOUT	Prints interference velocities at vortex-lattice control points and vortex strengths
WTHIN	Reads in wing thickness data and lays out thickness strips
WVLIN	Reads in wing vortex-lattice data and lays out vortices

```
C     AXISYMMETRIC SOURCE DISTRIBUTION PROGRAM                                  SOPA1   1
C                                                                               SOPA1   2
      DIMENSION C(100,101),Q(100),          XS(100),XEND( 7),COEF(, 7),       SOPA1   3
     1RA(100),XC(100),TB(100),JJJ(7),RL(100),DRDX(100),XX(7),RR(7)              SOPA1   4
  701 FORMAT(1H1)                                                               SOPA1   5
  702 FORMAT(I5,F10.5)                                                          SOPA1   6
  703 FORMAT(20A4)                                                              SOPA1   7
  704 FORMAT(1X,20A4)                                                           SOPA1   8
  705 FORMAT(8F10.5)                                                            SOPA1   9
  706 FORMAT(//1X,40HX/L OF END POINT OF EACH SECTION OF BODY/)                 SOPA1  10
  714 FORMAT(//1X,23HFOR THIS CASE THERE ARE,I4,8H SOURCES)                     SOPA1  11
  716 FORMAT(//1X,50HINCOMPRESSIBLE SOURCE DISTRIBUTION FOR MACH NUMBER,       SOPA1  12
     1F5.2)                                                                     SOPA1  13
  719 FORMAT(//1X,41HSHAPE CALCULATED FROM SOURCE DISTRIBUTION)                 SOPA1  14
  722 FORMAT(/2X,7HSECTION,5X,I2,6(8X,I2))                                      SOPA1  15
  723 FORMAT(2X,3HX/L,5X,7F10.5)                                                SOPA1  16
  724 FORMAT(//1X,51HCOEFFICIENTS OF POLYNOMIAL DESCRIBING EACH SECTION         SOPA1  17
     1//3X,7HSECTION,5X,2HC1,8X,2HC2,8X,2HC3,8X,2HC4,8X,2HC5,8X,2HC6,8X,       SOPA1  18
     22HC7)                                                                     SOPA1  19
  725 FORMAT(5X,I2,3X,7F10.5)                                                   SOPA1  20
  726 FORMAT(//1X,20HFIRST SOURCE AT X/L=,F8.5/1X,17HSOURCE SPACING IS,         SOPA1  21
     1F8.5,1X,30HTIMES LOCAL INCOMPRESSIBLE R/L)                                SOPA1  22
  727 FORMAT(//1X,69HSOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE         SOPA1  23
     1AT THESE LOCATIONS)                                                       SOPA1  24
  728 FORMAT(/3X,3HX/L,4X,7F10.5)                                               SOPA1  25
  729 FORMAT(3X,3HR/L,4X,7F10.5)                                                SOPA1  26
  730 FORMAT(3X,5HDR/DX,2X,7F10.5)                                              SOPA1  27
  731 FORMAT(/3X,3HX/L,2X,6(1PE12.4))                                           SOPA1  28
  732 FORMAT(3X,1HQ,4X,6(1PE12.4))                                              SOPA1  29
C                                                                               SOPA1  30
C     READ AND PRINT INPUT DATA                                                 SOPA1  31
C                                                                               SOPA1  32
    4 WRITE (6,701)                                                             SOPA1  33
      READ (5,702) NCARDS                                                       SOPA1  34
      IF (EOF(5)) 2000,2001
 2000 STOP
 2001 CONTINUE
      DO 1 J=1,NCARDS                                                           SOPA1  35
      READ (5,703) (Q(K),K=1,20)                                                SOPA1  36
    1 WRITE (6,704) (Q(K),K=1,20)                                               SOPA1  37
      READ (5,702) NSECT,FMACH                                                  SOPA1  38
      READ (5,705) (XEND(K),K=1,NSECT)                                          SOPA1  39
      WRITE (6,706)                                                             SOPA1  40
      BETA=SQRT(1.0-FMACH**2)                                                   SOPA1  41
      NEND=0                                                                    SOPA1  42
      DO 100 K=1,7                                                              SOPA1  43
  100 JJJ(K)=K                                                                  SOPA1  44
      WRITE (6,722) (JJJ(K),K=1,NSECT)                                          SOPA1  45
      WRITE (6,723) (XEND(K),K=1,NSECT)                                         SOPA1  46
      DO 2 J=1,NSECT                                                            SOPA1  47
    2 READ (5,705) (COEF(J,K),K=1,7)                                            SOPA1  48
      WRITE (6,724)                                                             SOPA1  49
      DO 3 J=1,NSECT                                                            SOPA1  50
    3 WRITE (6,725) J,(COEF(J,K), K=1,7)                                        SOPA1  51
      READ (5,705) XSFST,XSLST,PERCR,XRMAX,XINIT,XFINAL,DELX,RMAX               SOPA1  52
      RMAX=RMAX*BETA                                                            SOPA1  53
      WRITE (6,726) XSFST,PERCR                                                 SOPA1  54
C                                                                               SOPA1  55
C     CALCULATE SOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE              SOPA1  56
C         AT THESE LOCATIONS                                                    SOPA1  57
C                                                                               SOPA1  58
      XZ=XSFST                                                                  SOPA1  59
      J=1                                                                       SOPA1  60
   10 CALL SHAPE (XZ,NSECT,XEND,COEF,RL(J),DRDX(J))                            SOPA1  61
      XS(J)=XZ                                                                  SOPA1  62
      XZ=XZ+PERCR*RL(J)*BETA                                                    SOPA1  63
      J=J+1                                                                     SOPA1  64
      IF (J.LT.101) GO TO 20                                                    SOPA1  65
      WRITE (6,708)                                                             SOPA1  66
  708 FORMAT (//1X,21HMORE THAN 100 SOURCES)                                    SOPA1  67
      NSORC=100                                                                 SOPA1  68
      NEND=1                                                                    SOPA1  69
      GO TO 25                                                                  SOPA1  70
   20 IF (XZ.LE.XSLST) GO TO 10                                                 SOPA1  71
      NSORC=J-1                                                                 SOPA1  72
      WRITE (6,701)                                                             SOPA1  73
      WRITE (6,727)                                                             SOPA1  74
   25 NA=NSORC/7                                                                SOPA1  75
      NB=7*NA                                                                   SOPA1  76
      IF (NB.LT.NSORC) NA=NA+1                                                  SOPA1  77
      DO 101 J=1,NA                                                             SOPA1  78
      NB=7*(J-1)+1                                                              SOPA1  79
      NC=NB+6                                                                   SOPA1  80
      IF (NC.GT.NSORC) NC=NSORC                                                 SOPA1  81
      WRITE (6,728) (XS(N),N=NB,NC)                                             SOPA1  82
      WRITE (6,729) (RL(N),N=NB,NC)                                             SOPA1  83
  101 WRITE (6,730) (DRDX(N),N=NB,NC)                                           SOPA1  84
      IF (NEND.EQ.1) GO TO 4                                                    SOPA1  85
C                                                                               SOPA1  86
C     CALCULATE R/L AND DR/DX AT LOCATIONS WHERE FLOW ANGLE IMPOSED             SOPA1  87
C                                                                               SOPA1  88
      NM2=NSORC-2                                                               SOPA1  89
      NM1=NSORC-1                                                               SOPA1  90
      NP1=NSORC+1                                                               SOPA1  91
      J=0                                                                       SOPA1  92
   31 J=J+1                                                                     SOPA1  93
      IF (XS(J).LE.XRMAX) GO TO 31                                              SOPA1  94
      NPR=J-4                                                                   SOPA1  95
      DO 34 J=1,NM2                                                             SOPA1  96
      JP1=J+1                                                                   SOPA1  97
      IF (J.GT.NPR) GO TO 33                                                    SOPA1  98
      XZ=0.5*(XS(JP1)+XS(J))                                                    SOPA1  99
      XC(J)=XZ                                                                  SOPA1100
      GO TO 36                                                                  SOPA1101
   33 JP2=J+2                                                                   SOPA1102
      XZ=0.5*(XS(JP2)+XS(JP1))                                                  SOPA1103
      XC(J)=XZ                                                                  SOPA1104
   36 CALL SHAPE(XZ,NSECT,XEND,COEF,RA(J),TB(J))                               SOPA1105
      RA(J)=RA(J)*BETA                                                          SOPA1106
   34 TB(J)=TB(J)*BETA                                                          SOPA1107
C                                                                               SOPA1108
C     CALCULATE SOURCE DISTRIBUTION                                             SOPA1109
C                                                                               SOPA1110
C     CALCULATE COEFFICIENT MATRIX AND RIGHT HAND SIDE                          SOPA1111
C                                                                               SOPA1112
      EXA=1.5                                                                   SOPA1113
      EXB=2.0                                                                   SOPA1114
   62 DO 40 J=1,NM2                                                             SOPA1115
      XZ=XC(J)                                                                  SOPA1116
      XR=RA(J)                                                                  SOPA1117
      SL=TB(J)                                                                  SOPA1118
      XRS=XR*XR                                                                 SOPA1119
      DO 40 K=1,NSORC                                                           SOPA1120
   40 C(J,K)=(XR-SL*(XZ-XS(K)))/(((XZ-XS(K))**2+XRS)**EXA)                      SOPA1121
      DO 41 J=1,NSORC                                                           SOPA1122
      C(NM1,J)=1.0                                                              SOPA1123
   41 C(NSORC,J)=1.0/(XS(J)**EXB)                                               SOPA1124
      DO 42 J=1,NM2                                                             SOPA1125
   42 C(J,NP1)=TB(J)                                                            SOPA1126
      C(NM1,NP1)=0.0                                                            SOPA1127
      C(NSORC,NP1)=1.0                                                          SOPA1128
C                                                                               SOPA1129
C     SOLVE FOR SOURCE STRENGTHS                                                SOPA1130
C                                                                               SOPA1131
      CALL INVERS(C,1,NSORC,100,101)                                            SOPA1132
      DO 43 K=1,NSORC                                                           SOPA1133
   43 Q(K)=C(K,NP1)                                                             SOPA1134
C                                                                               SOPA1135
C     OUTPUT SOURCE LOCATIONS AND STRENGTHS                                     SOPA1136
C                                                                               SOPA1137
      WRITE (6,701)                                                             SOPA1138
      WRITE (6,714) NSORC                                                       SOPA1139
      WRITE (6,716) FMACH                                                       SOPA1140
      NAA=NSORC/6                                                               SOPA1141
      NBB=6*NAA                                                                 SOPA1142
```

(a) Page 1.

Figure 1.- Listing of source-distribution program.

```
      IF (NBB.LT.NSORC) NAA=NAA+1                                       SORA1143
      DO 102 J=1,NAA                                                    SORA1144
      NB=6*(J-1)+1                                                      SORA1145
      NC=NB+5                                                           SORA1146
      IF (NC.GT.NSORC) NC=NSORC                                         SORA1147
      WRITE (6,731) (XS(N),N=NB,NC)                                     SORA1148
  102 WRITE (6,732) (Q(N),N=NB,NC)                                      SORA1149
C                                                                       SORA1150
C     CALCULATE BODY SHAPE FROM SOURCE DISTRIBUTION                     SORA1151
C                                                                       SORA1152
      X=XINIT                                                           SORA1153
      EPS=5.0E-07                                                       SORA1154
      WRITE (6,701)                                                     SORA1155
      WRITE (6,719)                                                     SORA1156
      J=0                                                               SORA1157
   55 R=RMAX                                                            SORA1158
      J=J+1                                                             SORA1159
      M=1                                                               SORA1160
   52 PSI=R*R*0.5                                                       SORA1161
      DO 51 K=1,NSORC                                                   SORA1162
      XM=X-XS(K)                                                        SORA1163
   51 PSI=PSI-Q(K)*(1.0+XM/SQRT(XM*XM+R*R))                             SORA1164
      M=M+1                                                             SORA1165
      IF (ABS(PSI).LE.EPS) GO TO 54                                     SORA1166
      IF (PSI.LT.0.0) R=R+RMAX/(2.0**(M-1))                             SORA1167
      IF (PSI.GT.0.0) R=R-RMAX/(2.0**(M-1))                             SORA1168
      IF (R.LT.0.0001) GO TO 54                                         SORA1169
      IF (M.LT.20) GO TO 52                                             SORA1170
   54 XX(J)=X                                                           SORA1171
      RR(J)=R/BETA                                                      SORA1172
      IF (J.EQ.7) GO TO 200                                             SORA1173
   53 X=X+DELX                                                          SORA1174
      IF (X-XFINAL) 55,55,56                                            SORA1175
   56 IF (J.EQ.0) GO TO 4                                               SORA1176
  200 WRITE (6,728) (XX(N),N=1,J)                                       SORA1177
      WRITE (6,729) (RR(N),N=1,J)                                       SORA1178
      JJ=J                                                              SORA1179
      J=0                                                               SORA1180
      IF (JJ-7) 4,53,53                                                 SORA1181
      END                                                               SORA1182
```

```
C     SUBROUTINE TO SOLVE SIMULTANEOUS EQUATIONS                        SORA2  1
C                                                                       SORA2  2
      SUBROUTINE INVERS(A,NSYS,N,NMAX,MMAX)                             SORA2  3
      DIMENSION A(NMAX,MMAX),X(150)                                     SORA2  4
    5 SIGN=1.0                                                          SORA2  5
      NPI=N+1                                                           SORA2  6
      NMI=N-1                                                           SORA2  7
      NPLSY=N+NSYS                                                      SORA2  8
    9 DO 14 I=1,NMI                                                     SORA2  9
      IPI=I+1                                                           SORA2 10
      MAX=I                                                             SORA2 11
      AMAX=ABS(A(I,I))                                                  SORA2 12
      DO 10 K=IPI,N                                                     SORA2 13
      AKMAX=ABS(A(K,I))                                                 SORA2 14
      IF(AKMAX.LE.AMAX) GO TO 10                                        SORA2 15
      MAX=K                                                             SORA2 16
      AMAX=AKMAX                                                        SORA2 17
   10 CONTINUE                                                          SORA2 18
      IF(AMAX.LT.1.0E-12) GO TO 16                                      SORA2 19
      IF(MAX.EQ.I) GO TO 12                                             SORA2 20
      DO 11 L=I,NPLSY                                                   SORA2 21
      TEMP=A(I,L)                                                       SORA2 22
      A(I,L)=A(MAX,L)                                                   SORA2 23
   11 A(MAX,L)=TEMP                                                     SORA2 24
      SIGN=-SIGN                                                        SORA2 25
   12 DO 14 J=IPI,N                                                     SORA2 26
      IF (A(J,I)) 30,14,30                                              SORA2 27
   30 CONST=-A(J,I)/A(I,I)                                              SORA2 28
      DO 13 L=I,NPLSY                                                   SORA2 29
   13 A(J,L)=A(J,L)+A(I,L)*CONST                                        SORA2 30
   14 CONTINUE                                                          SORA2 31
      DET=0.0                                                           SORA2 32
      TEMP=1.0                                                          SORA2 33
      DO 15 I=1,N                                                       SORA2 34
      IF (A(I,I)) 15,16,15                                              SORA2 35
   15 TEMP=TEMP*A(I,I)                                                  SORA2 36
      DET=SIGN*TEMP                                                     SORA2 37
      GO TO 18                                                          SORA2 38
   16 WRITE(6,100)                                                      SORA2 39
  100 FORMAT(5X,18HMATRIX IS SINGULAR)                                  SORA2 40
      STOP                                                              SORA2 41
   18 DO 21 I=NPI,NPLSY                                                 SORA2 42
      DO 20 KK=1,N                                                      SORA2 43
      K=NPI-KK                                                          SORA2 44
      X(K)=A(K,I)                                                       SORA2 45
      IF(K.EQ.N) GO TO 20                                               SORA2 46
      J=K                                                               SORA2 47
   19 J=J+1                                                             SORA2 48
      X(K)=X(K)-A(K,J)*X(J)                                             SORA2 49
      IF(J.NE.N) GO TO 19                                               SORA2 50
   20 X(K)=X(K)/A(K,K)                                                  SORA2 51
      DO 21 J=1,N                                                       SORA2 52
   21 A(J,I)=X(J)                                                       SORA2 53
      RETURN                                                            SORA2 54
      END                                                               SORA2 55
```

```
C     SUBROUTINE TO CALCULATE SHAPE                                     SORA3  1
C                                                                       SORA3  2
      SUBROUTINE SHAPE (X,NS,XE,C,R,DRDX)                               SORA3  3
      DIMENSION XE(7),C(7,7)                                            SORA3  4
      DO 1 K=1,NS                                                       SORA3  5
      XL=XE(K)                                                          SORA3  6
      J=K                                                               SORA3  7
      IF (X.LE.XL) GO TO 2                                              SORA3  8
    1 CONTINUE                                                          SORA3  9
    2 R=C(J,1)+X*C(J,5)+X*X*C(J,6)                                      SORA3 10
      ARG=X*X*C(J,2)+X*C(J,3)+C(J,4)                                    SORA3 11
      DRDX=C(J,5)+2.0*X*C(J,6)                                          SORA3 12
      IF (ARG.LE.0.0) RETURN                                            SORA3 13
      R=R+SQRT(ARG)*C(J,7)                                              SORA3 14
      DRDX=DRDX+(2.0*X*C(J,2)+C(J,3))/(2.0*SQRT(ARG))*C(J,7)            SORA3 15
      RETURN                                                            SORA3 16
      END                                                               SORA3 17
```

(b) Page 2.

Figure 1.- Concluded.

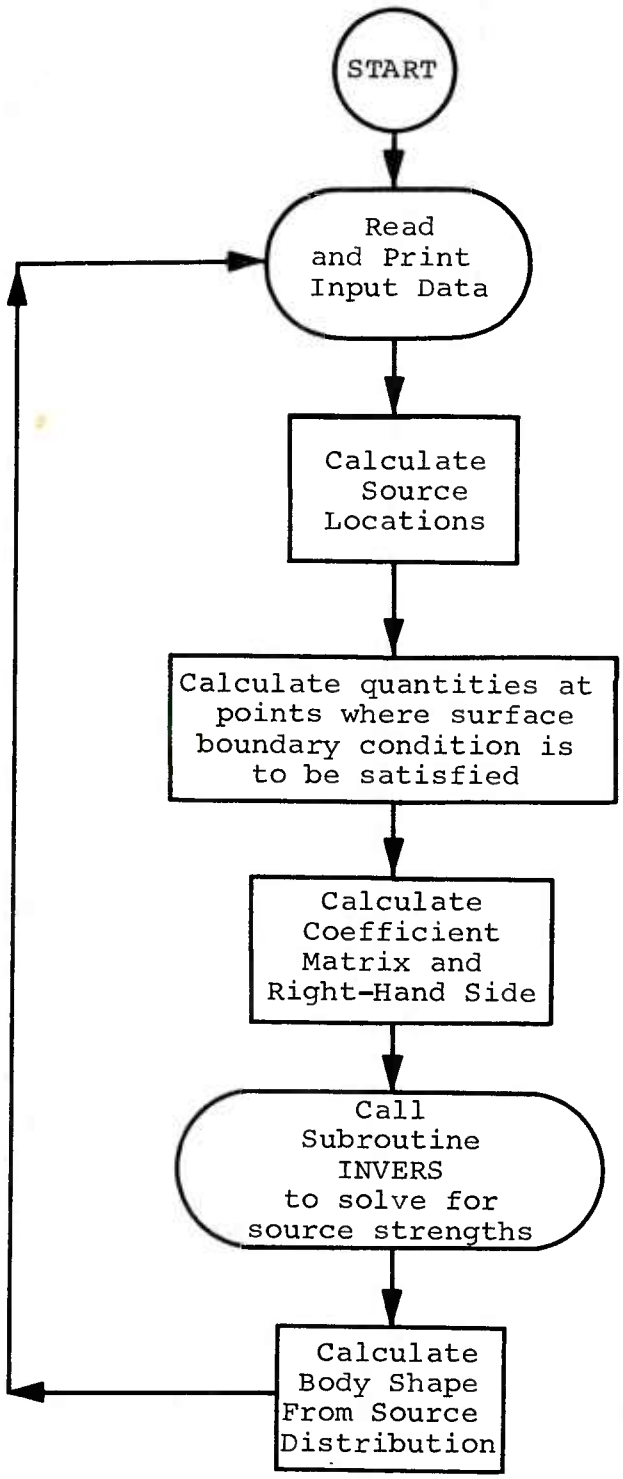


Figure 2.- General flow chart of source distribution program.

Item No. 1 (1 card)

Variable	NCARDS
Card Column	5
Format Type	I

Item No. 2 (NCARDS cards)

Variable	Q	
Card Column	1	80
Format Type	A	

Item No. 3 (1 card)

Variable	NSECT	FMACH
Card Column	5	15
Format Type	I	F

Item No. 4 (1 card)

Variable	XEND(1)	XEND(2)	...	XEND(NSECT)			
Card Column	10	20	30	40	50	60	70
Format Type	F	F	F	F	F	F	F

Item No. 5 (J = 1 to NSECT; NSECT cards)

Variable	COEF(J,1)	COEF(J,2)	COEF(J,3)	COEF(J,4)	COEF(J,5)	COEF(J,6)	COEF(J,7)
Card Column	10	20	30	40	50	60	70
Format Type	F	F	F	F	F	F	F

Item No. 6 (1 card)

Variable	XSFST	XSLST	PERCR	XRMAX	XINIT	XFINAL	DELX	RMAX
Card Column	10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Figure 3.- Source distribution program input format.

```
   2
OGIVE-CYLINDER STORE WITH WAKE MODELED WITH SAME SHAPE AS NOSE
     CALCULATION FOR MACH NUMBER OF 0.4
    3   0.4
  0.2353     1.0        1.2353
 -0.4413    -1.0        0.4706     0.1947                          1.0
  0.05882
 -0.4413    -1.0        2.0       -0.7499                          1.0
  0.002      1.23       0.7        0.2353     0.01       1.23      0.02      0.05882
```

(a) Ogive-cylinder store.

```
   2
FUSELAGE WITH WAKE MODELED BY CONTINUATION OF AFTERBODY
     CALCULATION FOR MACH NUMBER OF 0.4
    3   0.4
  0.32       0.7534     1.1752
 -1.0975    -1.0        0.64       1.2045                          1.0
  0.0457
 -1.9237    -1.0        1.5068     3.3109                          1.0
  0.002      1.17       1.0        0.32       0.01       1.17      0.02      0.0457
```

(b) Fuselage.

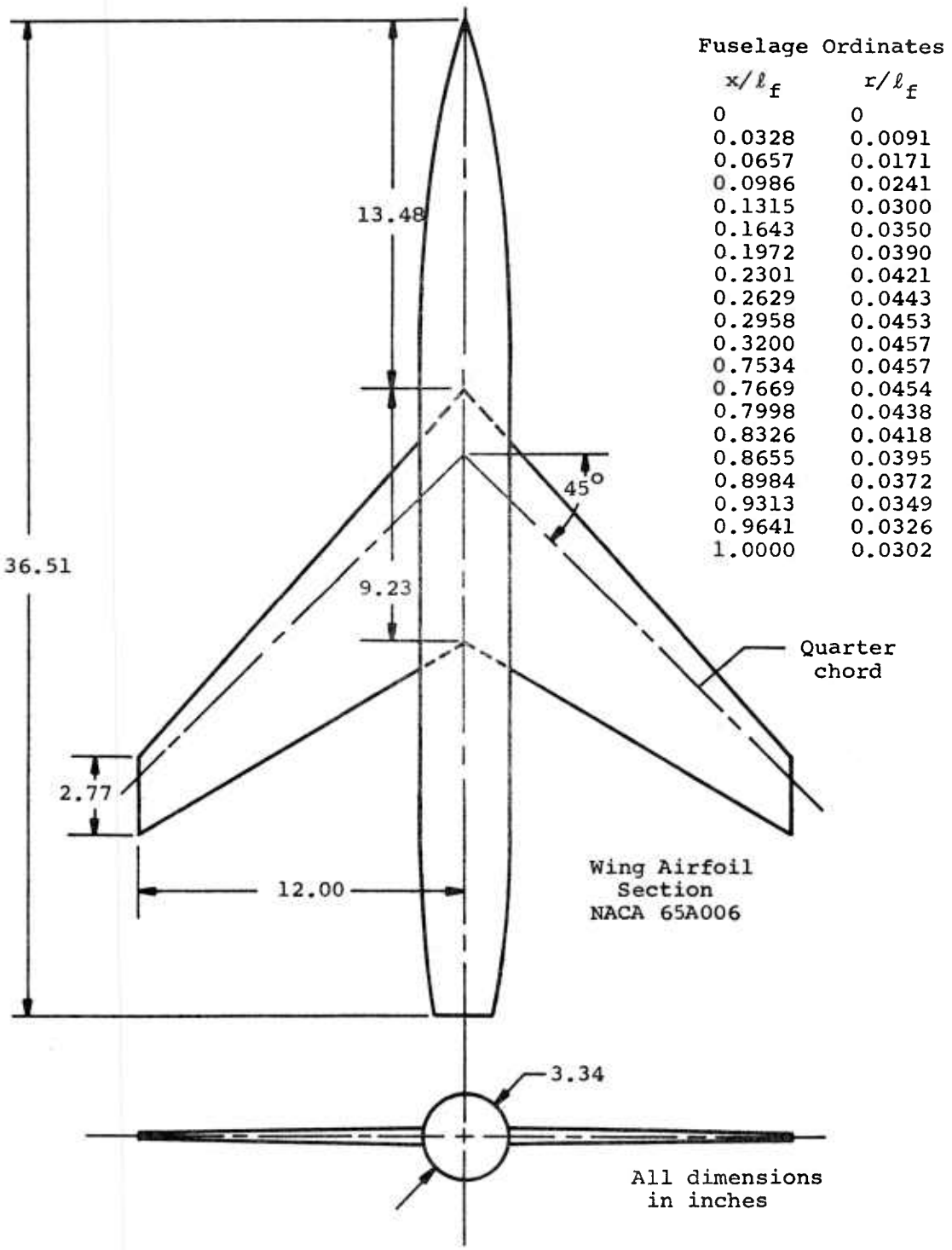
```
   2
SMALL BOATTAILED STORE WITH CIRCULAR ARC USED TO MODEL WAKE
     CALCULATION FOR MACH NUMBER OF 0.4
    7   0.4
    .0478      .1381      .3187      .7162      .8363     1.0        1.05
 -0.20198   -1.19048    0.27490    0.04080                          1.0
 -0.37945   -1.19048    0.40120    0.14655                          1.0
-70.50828   -1.19048   12.39448475.93318                           1.0
 -1.98790   -1.19048    1.09634    3.96180                          1.0
  1.00320   -1.19048    1.99121    0.10092                         -1.0
  0.03700
 -0.02172   -1.19048    2.38095   -1.18702                          1.0
  0.002      1.045      0.7        0.4316     0.01       1.03      0.02      0.0605
```

(c) Small boattail store.

```
   2
TER RACK WITH WAKE MODELED BY CONTINUATION OF AFTERBODY
     CALCULATION FOR MACH NUMBER OF 0.4
    3   0.4
  0.24424    0.89195    1.02936
             -0.05421   0.02648                                     1.0
  0.05687
 -0.13691    -1.0        1.7839   -0.75802                         1.0
  0.002      1.02       0.6        0.24424    0.01       1.01      0.02      0.05687
```

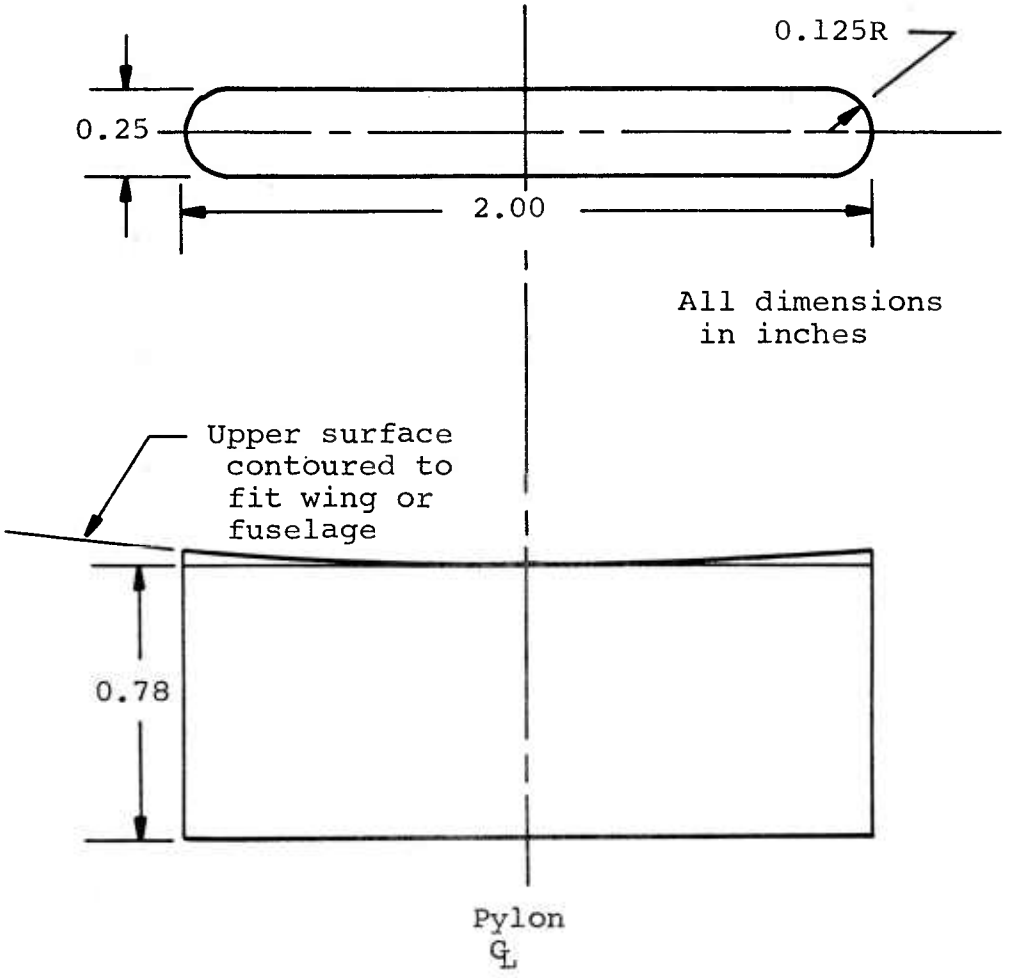
(d) Triple ejection rack.

Figure 4.- Sample input data for source distribution program.



(a) Wing-fuselage combination.

Figure 5.- Wind-tunnel models used in sample calculations.

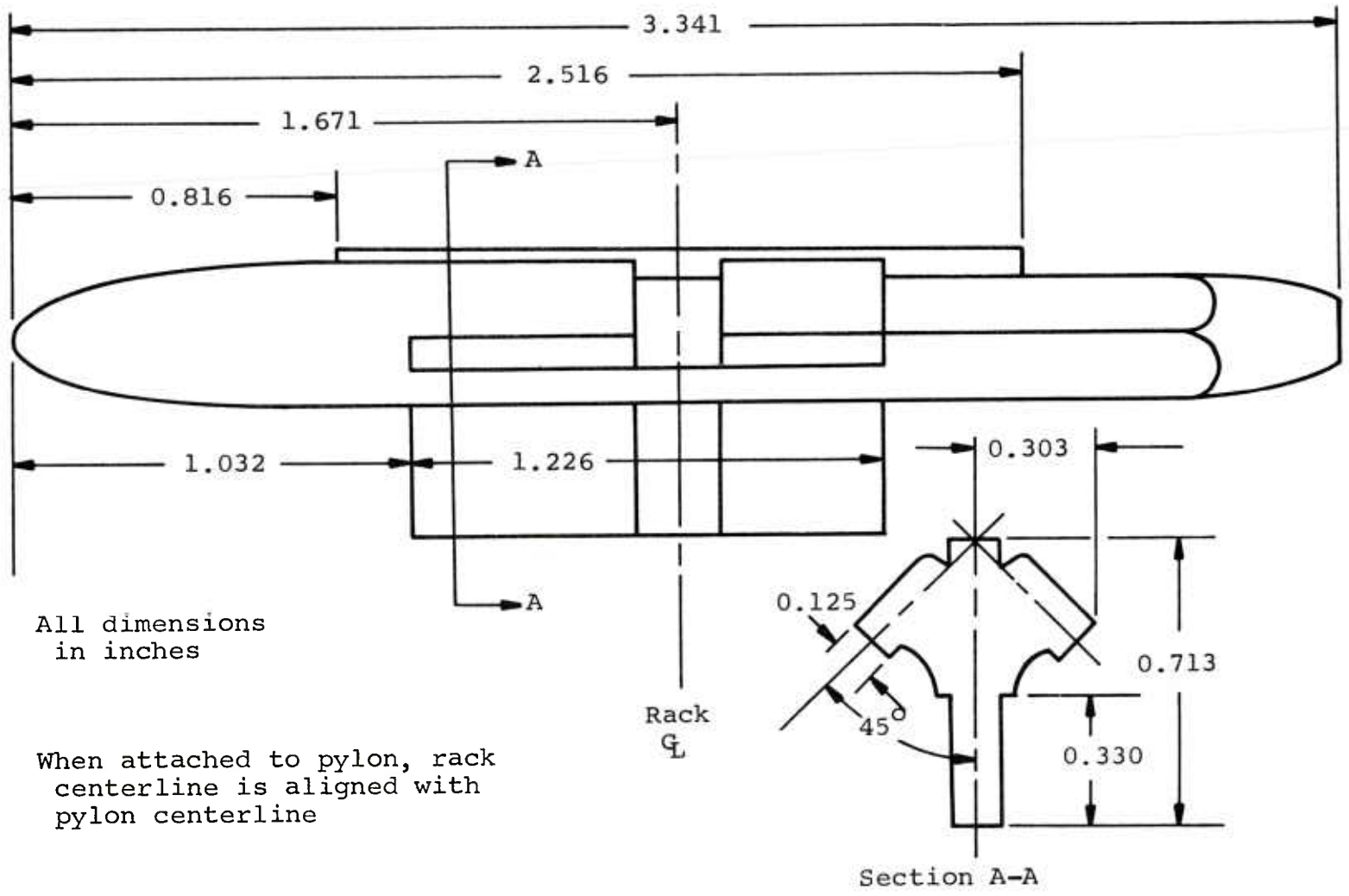


For wing pylons, pylon centerline located at 40% wing chord.

For fuselage pylon, pylon centerline located 19.43 inches aft of fuselage nose.

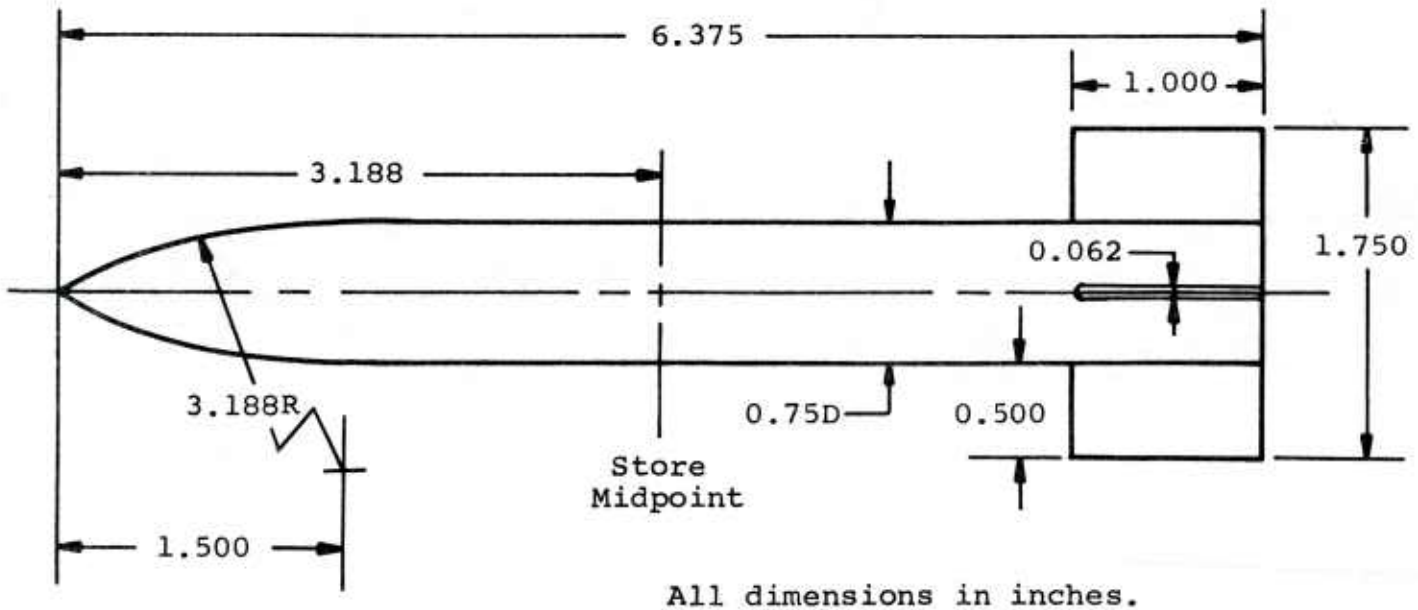
(b) Pylon used with single store and TER rack.

Figure 5.- Continued.



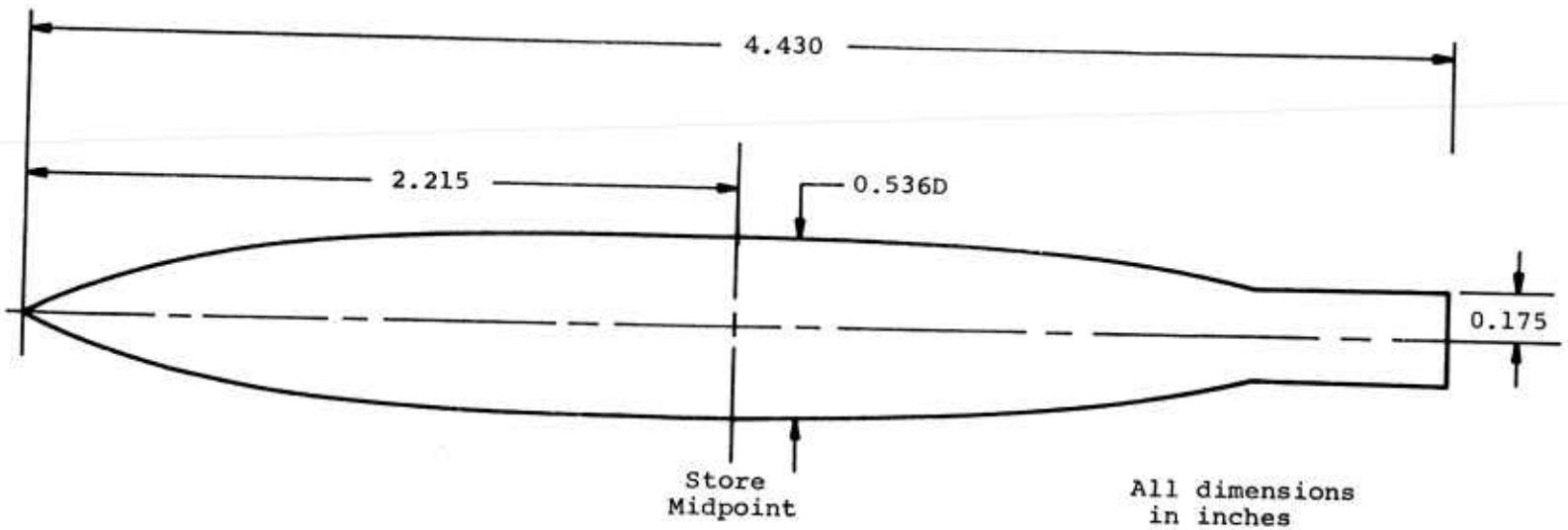
(c) Details of TER rack.

Figure 5.- Continued.



(d) Ogive-cylinder store with rectangular cruciform fins.

Figure 5.- Continued.



Store midpoint aligned with suspension centerline
on TER rack when in carriage position.

(e) Small boattail store.

Figure 5.- Concluded.

OGIVE-CYLINDER STORE WITH WAKE MODELED WITH SAME SHAPE AS NOSE
CALCULATION FOR MACH NUMBER OF 0.4

X/L OF END POINT OF EACH SECTION OF BODY

SECTION	1	2	3
X/L	.23530	1.00000	1.23530

COEFFICIENTS OF POLYNOMIAL DESCRIBING EACH SECTION

SECTION	C1	C2	C3	C4	C5	C6	C7
1	-.44130	-1.00000	.47060	.19470	.00000	.00000	1.00000
2	.05882	.00000	.00000	.00000	.00000	.00000	.00000
3	-.44130	-1.00000	2.00000	-.74990	.00000	.00000	1.00000

FIRST SOURCE AT X/L= .00200
SOURCE SPACING IS .70000 TIMES LOCAL INCOMPRESSIBLE R/L

(a) Page 1.

SOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE AT THESE LOCATIONS

X/L	.00200	.00265	.00351	.00467	.00621	.00827	.01101
R/L	.00101	.00135	.00180	.00241	.00321	.00426	.00564
DR/DX	.52746	.52559	.52310	.51978	.51537	.50953	.50184
X/L	.01463	.01940	.02566	.03381	.04432	.05770	.07449
R/L	.00744	.00976	.01270	.01638	.02086	.02617	.03220
DR/DX	.49176	.47865	.46176	.44025	.41324	.37992	.33963
X/L	.09515	.11999	.14904	.18194	.21781	.25531	.29305
R/L	.03872	.04529	.05127	.05591	.05846	.05882	.05882
DR/DX	.29197	.23698	.17511	.10732	.03500	.00000	.00000
X/L	.33079	.36852	.40626	.44400	.48173	.51947	.55721
R/L	.05882	.05882	.05882	.05882	.05882	.05882	.05882
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	.59494	.63268	.67042	.70815	.74589	.78363	.82136
R/L	.05882	.05882	.05882	.05882	.05882	.05882	.05882
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	.85910	.89684	.93457	.97231	1.01005	1.04778	1.08397
R/L	.05882	.05882	.05882	.05882	.05870	.05652	.05170
DR/DX	.00000	.00000	.00000	.00000	-.02009	-.09583	-.17032
X/L	1.11713	1.14593	1.16969	1.18838	1.20247	1.21272	1.21998
R/L	.04489	.03703	.02913	.02196	.01598	.01130	.00782
DR/DX	-.24092	-.30509	-.36072	-.40664	-.44277	-.47000	-.48979
X/L	1.22499	1.22841					
R/L	.00533	.00359					
DR/DX	-.50376	-.51341					

(b) Page 2.

FOR THIS CASE THERE ARE 51 SOURCES

INCOMPRESSIBLE SOURCE DISTRIBUTION FOR MACH NUMBER .40

X/L	2.0000-03	2.6473-03	3.5132-03	4.6705-03	6.2149-03	8.2721-03
Q	4.8513-06	-4.3213-06	2.4426-06	-7.1054-07	1.2638-06	1.0933-06
X/L	1.1000-02	1.4626-02	1.9400-02	2.5061-02	3.3810-02	4.4816-02
Q	2.5749-06	4.3291-06	7.8030-06	1.3510-05	2.3010-05	3.7907-05
X/L	5.7099-02	7.4485-02	9.5145-02	1.1999-01	1.4904-01	1.8104-01
Q	5.9954-05	8.9502-05	1.2214-04	1.5482-04	1.9220-04	2.0261-04
X/L	2.1781-01	2.5531-01	2.9305-01	3.3079-01	3.6852-01	4.0626-01
Q	-5.0476-05	-1.1394-04	1.1594-04	-1.2468-04	1.2050-04	-1.2326-04
X/L	4.4400-01	4.8173-01	5.1947-01	5.5721-01	5.9494-01	6.3268-01
Q	1.2144-04	-1.2266-04	1.2185-04	-1.2235-04	1.2211-04	-1.2213-04
X/L	6.7042-01	7.0815-01	7.4589-01	7.8363-01	8.2136-01	8.5910-01
Q	1.2233-04	-1.2188-04	1.2263-04	-1.2149-04	1.2316-04	-1.2063-04
X/L	8.9684-01	9.3457-01	9.7231-01	1.0100+00	1.0477+00	1.0844+00
Q	1.2450-04	-1.1674-04	1.1695-04	1.1480-05	-1.1924-04	-1.7271-04
X/L	1.1171+00	1.1459+00	1.1697+00	1.1884+00	1.2025+00	1.2127+00
Q	-1.7495-04	-1.3912-04	-9.3587-05	-5.4285-05	-2.9966-05	-1.2530-05
X/L	1.2200+00	1.2250+00	1.2284+00			
Q	-1.0227-05	4.6640-06	-1.1713-05			

(c) Page 3.

SHAPE CALCULATED FROM SOURCE DISTRIBUTION

X/L	.01000	.03000	.05000	.07000	.09000	.11000	.13000
R/L	.00597	.01499	.02352	.03079	.03768	.04291	.04702
X/L	.15000	.17000	.19000	.21000	.23000	.25000	.27000
R/L	.05152	.05474	.05715	.05858	.05908	.05904	.05869
X/L	.29000	.31000	.33000	.35000	.37000	.39000	.41000
R/L	.05896	.05908	.05899	.05888	.05899	.05908	.05896
X/L	.43000	.45000	.47000	.49000	.51000	.53000	.55000
R/L	.05869	.05904	.05906	.05892	.05891	.05906	.05905
X/L	.57000	.59000	.61000	.63000	.65000	.67000	.69000
R/L	.05891	.05895	.05908	.05901	.05868	.05899	.05908
X/L	.71000	.73000	.75000	.77000	.79000	.81000	.83000
R/L	.05896	.05889	.05902	.05908	.05893	.05891	.05905
X/L	.85000	.87000	.89000	.91000	.93000	.95000	.97000
R/L	.05905	.05891	.05893	.05908	.05902	.05889	.05896
X/L	.99000	1.01000	1.03000	1.05000	1.07000	1.09000	1.11000
R/L	.05911	.05889	.05806	.05646	.05405	.05081	.04673
X/L	1.13000	1.15000	1.17000	1.19000	1.21000	1.23000	
R/L	.04182	.03602	.02952	.02177	.01344	.00460	

(d) Page 4.

Figure 6.- Ogive-cylinder store source distribution output.

FUSELAGE WITH WAKE MODELED BY CONTINUATION OF AFTERBODY
CALCULATION FOR MACH NUMBER OF 0.4

X/L OF END POINT OF EACH SECTION OF BODY

SECTION	1	2	3
X/L	.32000	.75340	1.17520

COEFFICIENTS OF POLYNOMIAL DESCRIBING EACH SECTION

SECTION	C1	C2	C3	C4	C5	C6	C7
1	-1.09750	-1.00000	.64000	1.20950	.00000	.00000	1.00000
2	.04570	.00000	.00000	.00000	.00000	.00000	.00000
3	-1.92370	-1.00000	1.50680	3.31090	.00000	.00000	1.00000

FIRST SOURCE AT X/L= .00200
SOURCE SPACING IS 1.00000 TIMES LOCAL INCOMPRESSIBLE R/L

(a) Page 1.

SOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE AT THESE LOCATIONS

X/L	.00200	.00253	.00320	.00405	.00512	.00647	.00818
R/L	.00058	.00073	.00093	.00117	.00148	.00186	.00235
DR/DX	.28960	.28907	.28841	.28758	.28652	.28519	.28351
X/L	.01034	.01305	.01646	.02073	.02607	.03273	.04099
R/L	.00296	.00372	.00466	.00583	.00727	.00902	.01113
DR/DX	.28139	.27874	.27541	.27124	.26605	.25962	.25167
X/L	.05119	.06370	.07891	.09722	.11902	.14458	.17406
R/L	.01364	.01660	.01999	.02378	.02789	.03216	.03634
DR/DX	.24192	.23005	.21575	.19868	.17859	.15528	.12872
X/L	.20737	.24415	.28372	.32508	.36696	.40885	.45073
R/L	.04014	.04318	.04512	.04570	.04570	.04570	.04570
DR/DX	.09901	.06649	.03175	.00000	.00000	.00000	.00000
X/L	.49262	.53450	.57639	.61827	.66016	.70204	.74393
R/L	.04570	.04570	.04570	.04570	.04570	.04570	.04570
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	.78581	.82745	.86805	.90687	.94326	.97673	1.00696
R/L	.04543	.04430	.04235	.03971	.03652	.03299	.02930
DR/DX	-.01646	-.03762	-.05831	-.07816	-.09685	-.11414	-.12983
X/L	1.03382	1.05731	1.07757	1.09483	1.10937	1.12152	1.13159
R/L	.02563	.02210	.01863	.01567	.01326	.01098	.00904
DR/DX	-.14385	-.15619	-.16668	-.17603	-.18378	-.19027	-.19567
X/L	1.13987	1.14666	1.15218	1.15667	1.16030	1.16324	1.16560
R/L	.00740	.00603	.00490	.00396	.00320	.00258	.00207
DR/DX	-.20013	-.20379	-.20677	-.20920	-.21117	-.21276	-.21404
X/L	1.16750	1.16903					
R/L	.00167	.00134					
DR/DX	-.21508	-.21591					

(b) Page 2.

FOR THIS CASE THERE ARE 58 SOURCES

INCOMPRESSIBLE SOURCE DISTRIBUTION FOR MACH NUMBER .40

X/L	2.0000E-03	2.5300E-03	3.2006E-03	4.0487E-03	5.1206E-03	6.4785E-03
Q	6.0353E-06	-5.4782E-06	3.5396E-06	-2.1783E-06	1.6162E-06	-6.6962E-07
X/L	8.1831E-03	1.0357E-02	1.3046E-02	1.6456E-02	2.0729E-02	2.6072E-02
Q	1.0445E-06	3.1040E-07	1.3737E-06	1.6004E-06	2.8780E-06	4.2266E-06
X/L	3.2730E-02	4.0995E-02	5.1192E-02	6.3697E-02	7.8987E-02	9.7224E-02
Q	6.6436E-06	9.9387E-06	1.4813E-05	2.1403E-05	3.0085E-05	4.0582E-05
X/L	1.1902E-01	1.4458E-01	1.7406E-01	2.0737E-01	2.4415E-01	2.8372E-01
Q	5.2073E-05	6.2487E-05	6.8767E-05	6.2946E-05	7.3261E-05	4.5069E-06
X/L	3.2508E-01	3.6696E-01	4.0885E-01	4.5073E-01	4.9262E-01	5.3450E-01
Q	-7.6829E-07	-1.2766E-05	9.9914E-06	-1.1501E-05	1.0717E-05	-1.1046E-05
X/L	5.7639E-01	6.1827E-01	6.6016E-01	7.0204E-01	7.4393E-01	7.8581E-01
Q	1.1063E-05	-1.0703E-05	1.1555E-05	-9.8993E-06	1.6496E-05	-1.3298E-05
X/L	8.2745E-01	8.6805E-01	9.0687E-01	9.4326E-01	9.7673E-01	1.0070E+00
Q	-3.1426E-05	-4.5538E-05	-5.3835E-05	-5.6492E-05	-5.3967E-05	-4.8229E-05
X/L	1.0338E+00	1.0573E+00	1.0776E+00	1.0948E+00	1.1094E+00	1.1215E+00
Q	-4.0372E-05	-3.2497E-05	-2.4705E-05	-1.8652E-05	-1.3021E-05	-9.7406E-06
X/L	1.1316E+00	1.1399E+00	1.1467E+00	1.1522E+00	1.1567E+00	1.1603E+00
Q	-5.9458E-06	-5.1105E-06	-1.9394E-06	-3.3603E-06	7.1284E-07	-3.6456E-06
X/L	1.1632E+00	1.1656E+00	1.1675E+00	1.1690E+00		
Q	3.4910E-06	-6.0077E-06	8.0640E-06	-9.4139E-06		

(c) Page 3.

SHAPE CALCULATED FROM SOURCE DISTRIBUTION

X/L	.01000	.03000	.05000	.07000	.09000	.11000	.13000
R/L	.00464	.00910	.01383	.01839	.02263	.02651	.03004
X/L	.15000	.17000	.19000	.21000	.23000	.25000	.27000
R/L	.03325	.03606	.03854	.04068	.04253	.04409	.04519
X/L	.29000	.31000	.33000	.35000	.37000	.39000	.41000
R/L	.04579	.04612	.04628	.04630	.04626	.04624	.04628
X/L	.43000	.45000	.47000	.49000	.51000	.53000	.55000
R/L	.04630	.04628	.04624	.04626	.04630	.04628	.04624
X/L	.57000	.59000	.61000	.63000	.65000	.67000	.69000
R/L	.04626	.04630	.04628	.04624	.04624	.04628	.04630
X/L	.71000	.73000	.75000	.77000	.79000	.81000	.83000
R/L	.04624	.04624	.04626	.04619	.04592	.04543	.04476
X/L	.85000	.87000	.89000	.91000	.93000	.95000	.97000
R/L	.04387	.04280	.04150	.03999	.03831	.03639	.03430
X/L	.99000	1.01000	1.03000	1.05000	1.07000	1.09000	1.11000
R/L	.03195	.02946	.02673	.02383	.02071	.01741	.01392
X/L	1.13000	1.15000	1.17000				
R/L	.01035	.00696	.00321				

(d) Page 4.

Figure 7.- Fuselage source distribution output.

SMALL BOATTAILED STORE WITH CIRCULAR ARC USED TO MODEL WAKE
CALCULATION FOR MACH NUMBER OF 0.4

X/L OF END POINT OF EACH SECTION OF BODY

SECTION	1	2	3	4	5	6	7
X/L	.04780	.13810	.31870	.71620	.85650	1.00000	1.05000

COEFFICIENTS OF POLYNOMIAL DESCRIBING EACH SECTION

SECTION	C1	C2	C3	C4	C5	C6	C7
1	-.20198	-1.19048	.27490	.04080	.00000	.00000	1.00000
2	-.37945	-1.19048	.40120	.14655	.00000	.00000	1.00000
3	-70.50828	-1.19048	12.394484975.93317		.00000	.00000	1.00000
4	-1.98790	-1.19048	1.09634	3.96186	.00000	.00000	1.00000
5	1.00320	-1.19048	1.99121	.10092	.00000	.00000	-1.00000
6	.03700	.00000	.00000	.00000	.00000	.00000	.00000
7	-.02172	-1.19048	2.38095	-1.18702	.00000	.00000	1.00000

FIRST SOURCE AT X/L= .00200
SOURCE SPACING IS .70000 TIMES LOCAL INCOMPRESSIBLE B/L

(a) Page 1.

SOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE AT THESE LOCATIONS

X/L	.00200	.00287	.00411	.00586	.00834	.01181	.01662
R/L	.00135	.00193	.00274	.00386	.00541	.00750	.01025
DR/DX	.66427	.65732	.64753	.63384	.61489	.58904	.55444
X/L	.02319	.03201	.04354	.05815	.07598	.09719	.12159
R/L	.01374	.01797	.02277	.02780	.03306	.03804	.04213
DR/DX	.50918	.45167	.38095	.32260	.26702	.20336	.13247
X/L	.14862	.17742	.20779	.23980	.27354	.30909	.34653
R/L	.04488	.04733	.04990	.05259	.05541	.05836	.06120
DR/DX	.08533	.08484	.08433	.08378	.08321	.08261	.06619
X/L	.38580	.42644	.46791	.50958	.55081	.59097	.62948
R/L	.06335	.06463	.06495	.06427	.06260	.06002	.05667
DR/DX	.04333	.01973	-.00432	-.02849	-.05246	-.07587	-.09842
X/L	.66584	.69965	.73065	.75881	.78492	.80970	.83372
R/L	.05270	.04831	.04390	.04070	.03862	.03743	.03700
DR/DX	-.11982	-.13984	-.13112	-.09585	-.06342	-.03279	-.00319
X/L	.85746	.88119	.90493	.92867	.95241	.97614	.99988
R/L	.03700	.03700	.03700	.03700	.03700	.03700	.03700
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	1.02362	1.04355					
R/L	.03106	.01281					
DR/DX	-.53288	-1.50162					

(b) Page 2.

FOR THIS CASE THERE ARE 44 SOURCES

INCOMPRESSIBLE SOURCE DISTRIBUTION FOR MACH NUMBER .40

X/L	2.0000-03	2.8692-03	4.1066-03	5.8825-03	8.3399-03	1.1810-02
Q	3.8950-06	-2.9405-06	1.8989-06	5.6064-07	2.6286-06	4.7915-06
X/L	1.6619-02	2.3192-02	3.2007-02	4.3538-02	5.8146-02	7.5981-02
Q	9.7339-06	1.8419-05	3.2418-05	5.3617-05	5.6472-05	9.3566-05
X/L	9.7189-02	1.2159-01	1.4862-01	1.7742-01	2.0779-01	2.3980-01
Q	8.9716-05	9.5866-05	-5.8868-05	1.3457-04	-2.0499-05	1.2904-04
X/L	2.7354-01	3.0909-01	3.4653-01	3.8580-01	4.2644-01	4.6791-01
Q	1.0512-05	1.3466-04	9.0154-05	-2.6121-05	1.2754-04	-1.0695-04
X/L	5.0958-01	5.5081-01	5.9097-01	6.2948-01	6.6584-01	6.9965-01
Q	6.5856-05	-1.7406-04	3.1092-05	-2.3365-04	4.9612-05	-2.8651-04
X/L	7.3065-01	7.5881-01	7.8492-01	8.0970-01	8.3372-01	8.5746-01
Q	8.2015-05	-2.0799-04	1.6871-04	-2.1783-04	2.2493-04	-2.1059-04
X/L	8.8119-01	9.0493-01	9.2867-01	9.5241-01	9.7614-01	9.9988-01
Q	2.1369-04	-2.0999-04	2.1386-04	-2.0582-04	1.9470-04	2.2062-05
X/L	1.0236+00	1.0435+00				
Q	-4.1387-04	1.8464-05				

(c) Page 3.

SHAPE CALCULATED FROM SOURCE DISTRIBUTION

X/L	.01000	.03000	.05000	.07000	.09000	.11000	.13000
R/L	.00709	.01725	.02523	.03152	.03660	.04050	.04322
X/L	.15000	.17000	.19000	.21000	.23000	.25000	.27000
R/L	.04496	.04662	.04845	.05004	.05170	.05347	.05511
X/L	.29000	.31000	.33000	.35000	.37000	.39000	.41000
R/L	.05672	.05840	.06003	.06139	.06242	.06316	.06381
X/L	.43000	.45000	.47000	.49000	.51000	.53000	.55000
R/L	.06437	.06467	.06459	.06430	.06391	.06329	.06229
X/L	.57000	.59000	.61000	.63000	.65000	.67000	.69000
R/L	.06103	.05972	.05820	.05619	.05394	.05181	.04930
X/L	.71000	.73000	.75000	.77000	.79000	.81000	.83000
R/L	.04605	.04328	.04103	.03858	.03766	.03654	.03598
X/L	.85000	.87000	.89000	.91000	.93000	.95000	.97000
R/L	.03639	.03580	.03642	.03595	.03622	.03625	.03595
X/L	.99000	1.01000	1.03000				
R/L	.03654	.03439	.02493				

(d) Page 4.

Figure 8.- Small boattail store source distribution output.

TER RACK WITH WAKE MODELED BY CONTINUATION OF AFTERBODY
CALCULATION FOR MACH NUMBER OF 0.4

X/L OF END POINT OF EACH SECTION OF BODY

SECTION	1	2	3
X/L	.24424	.89195	1.02956

COEFFICIENTS OF POLYNOMIAL DESCRIBING EACH SECTION

SECTION	C1	C2	C3	C4	C5	C6	C7
1	.00000	-.05421	.02648	.00000	.00000	.00000	1.00000
2	.05687	.00000	.00000	.00000	.00000	.00000	.00000
3	-.13691	-1.00000	1.78390	-.75802	.00000	.00000	1.00000

FIRST SOURCE AT X/L= .00200
SOURCE SPACING IS .60000 TIMES LOCAL INCOMPRESSIBLE R/L

(a) Page 1.

SOURCE LOCATIONS AND BODY RADIUS AND SURFACE SLOPE AT THESE LOCATIONS

X/L	.00200	.00599	.01288	.02290	.03612	.05249	.07185
R/L	.00726	.01252	.01822	.02404	.02976	.03522	.04028
DR/DX	1.80815	1.03151	.68828	.49910	.37909	.29513	.23197
X/L	.09401	.11866	.14548	.17408	.20404	.23488	.26613
R/L	.04484	.04877	.05201	.05447	.05609	.05682	.05687
DR/DX	.18164	.13957	.10293	.06982	.03885	.00892	.00000
X/L	.29740	.32867	.35995	.39122	.42249	.45377	.46504
R/L	.05687	.05687	.05687	.05687	.05687	.05687	.05687
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	.51631	.54759	.57886	.61013	.64141	.67268	.70395
R/L	.05687	.05687	.05687	.05687	.05687	.05687	.05687
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	.00000
X/L	.73523	.76650	.79777	.82905	.86032	.89159	.92287
R/L	.05687	.05687	.05687	.05687	.05687	.05687	.05440
DR/DX	.00000	.00000	.00000	.00000	.00000	.00000	-.16161
X/L	.95278	.97867	.99869	1.01235			
R/L	.04709	.03639	.02484	.01494			
DR/DX	-.33062	-.50042	-.65990	-.79283			

(b) Page 2.

FOR THIS CASE THERE ARE 39 SOURCES

INCOMPRESSIBLE SOURCE DISTRIBUTION FOR MACH NUMBER .40

X/L	2.0000-03	5.9937-03	1.2879-02	2.2894-02	3.6119-02	5.2495-02
Q	-5.6044-07	2.0447-05	5.2145-05	6.6002-05	8.0062-05	8.8621-05
X/L	7.1853-02	9.4006-02	1.1666-01	1.4548-01	1.7406-01	2.0404-01
Q	9.2691-05	9.0897-05	8.2019-05	7.5763-05	1.7833-05	1.2050-04
X/L	2.3488-01	2.6613-01	2.9740-01	3.2867-01	3.5995-01	3.9122-01
Q	-1.1640-04	5.3828-05	-5.1306-05	4.5747-05	-4.8286-05	4.6454-05
X/L	4.2249-01	4.5377-01	4.8504-01	5.1631-01	5.4759-01	5.7886-01
Q	-4.7669-05	4.6862-05	-4.7357-05	4.7119-05	-4.7125-05	4.7348-05
X/L	6.1013-01	6.4141-01	6.7268-01	7.0395-01	7.3523-01	7.6650-01
Q	-4.6877-05	4.7641-05	-4.6504-05	4.8151-05	-4.5770-05	4.9387-05
X/L	7.9777-01	8.2905-01	8.6032-01	8.9159-01	9.2287-01	9.5278-01
Q	-4.4521-05	5.8037-05	-7.4067-05	2.8150-04	-2.9126-04	-3.0856-04
X/L	9.7867-01	9.9869-01	1.0123+00			
Q	-2.1453-04	-7.9127-05	-4.6523-05			

(c) Page 3.

SHAPE CALCULATED FROM SOURCE DISTRIBUTION

X/L	.01000	.03000	.05000	.07000	.09000	.11000	.13000
R/L	.01622	.02738	.03452	.03988	.04412	.04754	.05029
X/L	.15000	.17000	.19000	.21000	.23000	.25000	.27000
R/L	.05248	.05420	.05558	.05659	.05706	.05712	.05715
X/L	.29000	.31000	.33000	.35000	.37000	.39000	.41000
R/L	.05715	.05712	.05715	.05715	.05712	.05713	.05715
X/L	.43000	.45000	.47000	.49000	.51000	.53000	.55000
R/L	.05712	.05712	.05715	.05712	.05712	.05715	.05713
X/L	.57000	.59000	.61000	.63000	.65000	.67000	.69000
R/L	.05712	.05715	.05715	.05712	.05715	.05715	.05712
X/L	.71000	.73000	.75000	.77000	.79000	.81000	.83000
R/L	.05715	.05715	.05712	.05715	.05715	.05712	.05713
X/L	.85000	.87000	.89000	.91000	.93000	.95000	.97000
R/L	.05715	.05715	.05704	.05602	.05314	.04801	.04049
X/L	.99000	1.01000					
R/L	.03030	.01699					

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Figure 9.- Triple ejector rack source distribution output.

```
C     PROGRAM TO CALCULATE SIX-DEGREE-OF-FREEDOM STORE TRAJECTORIES      6DA01  1
C                                                                        6DA01  2
C     DIMENSION STATEMENTS                                               6DA01  3
C                                                                        6DA01  4
      DIMENSION ALPHAL(120),ALPHL1(120),CHLOCB(31),CHLOCL(31),COSPHI(120 6DA01  5
     1),DELTX(31),DELTPX(5),FXL(100),FSOR(100),FACTOR(400),FVN(100,101),6DA01  6
     2FACTOP(180),HEAD(20)                                              6DA01  7
      DIMENSION NUMSTR(10),NSHAPE(10),NSSOR(10)                         6DA01  8
      DIMENSION PSIWLE(31),PSIWTE(31),PHID(31),PHI(120),PVX(120),PVY(120 6DA01  9
     1),PVZ(120),PCX(120),PTLX(120),PTLY(120),PTLZ(120),PVPX(30),PVPY(30 6DA01 10
     2),PVPZ(30),PCPX(30),RXL(100),RSOR(100)                            6DA01 11
      DIMENSION SWPWLI(31),SWPWTI(31),SUMY(31),SWPC(120),SWPV(120),     6DA01 12
     1SINPHI(120),SWPVV(120),SW(120),SWPCS(400),SUMZ(5),SWPCP(10),      6DA01 13
     2SWPVP(30),SP(30),SLTHC(10),SLTHI(10),SRMAX(10),SIC(10),SII(10),   6DA01 14
     3SXL(100,10),SSOR(100,10),SWPPCS(180)                              6DA01 15
      DIMENSION TANPHI(31),THETAL(400),THETPL(180),XLEL(31),XRC(400),   6DA01 16
     1XSNC(10),XSNI(10),XWSOI(10),XPRC(180),Y(31),YLOC(31),YSN(10),     6DA01 17
     2YWSO(10),ZLEL(31),Z1(400),Z(5),ZSN(10),ZWSO(10)                   6DA01 18
      DIMENSION SIIR(10),CSIIR(10),SSIIR(10),CIR(150),UEI(150),VEI(150),6DA01 19
     1WEI(150),SINSPS(180),COSSPS(180),SINSWS(400),COSSWS(400)          6DA01 20
      DIMENSION XEND(7),COEF(7,7),ERAD(81),EDRDX(81),EXSTI(81),EXST(81),6DA01 21
     1SIBIR(10),CSIBIR(10),SSIBIR(10),YBSO(10),ZBSO(10),XBSOI(10),      6DA01 22
     2VAR(12),DVAR(12),CNX(40),CYX(40),UT(81),VT(81),WT(81),DC(3,3)     6DA01 23
      DIMENSION SIBCR(10),CSIBCR(10),SSIBCR(10),XBSO(10)                6DA01 24
C                                                                        6DA01 25
C     COMMON STATEMENTS                                                  6DA01 26
C                                                                        6DA01 27
      COMMON /COUTPT/ TIME,EXST,DVAR,ESTLGC                             6DA01 28
      COMMON /CVLIVL/ PVX,PVY,PVZ,SWPVV,PHI,SW,CIR,PVPX,PVPY,PVPZ,SWPVP,6DA01 29
     1SP                                                                6DA01 30
      COMMON/1FORCE/NHSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NHSEGO           6DA01 31
      COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBROI,ZBRO,YBRO,XBSOI,CSIBIR,6DA01 32
     1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTORE,XMOM,ESTRMX,CDC,CNBY,CYBY,    6DA01 33
     2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,EDRDX,CNCF,   6DA01 34
     3CYCF,CLMCF,CLNCF                                                  6DA01 35
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA01 36
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA01 37
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA01 38
      COMMON /PYLON/ PSIPLE,PSIPTE,CRP,H,XPLE,SWPPLE,SWPPTE             6DA01 39
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWL1,6DA01 40
     1,SWPWTI,XLEL,ZLEL                                                 6DA01 41
      COMMON /LOCA/ WIIR,CWIIR,SWIIR,XBWOI,ZBWO,XWROI,YWRO,ZWRO,RIIR,   6DA01 42
     1CRIIR,SRIIR,SIIR,CSIIR,SSIIR,XWSOI,YWSO,ZWSO                      6DA01 43
      COMMON /SOURCE/ FXL,FSOR,NFSOR,FRMAX,RXL,RSOR,NRSOR,RRMAX,SXL,SSOR6DA01 44
     1,NSSOR,SRMAX                                                      6DA01 45
      COMMON /WTHICK/ SWPCS,SINSWS,COSSWS,XRC,Z1,FACTOR                 6DA01 46
      COMMON /PTHICK/ FACTOP,SWPPCS,XPRC,Z,SINSPS,COSSPS                6DA01 47
      COMMON /EMPDAT/ FINSS,RADAV,XTAIL,PHIROL,MSF,IPLNR,CLALPH         6DA01 48
      COMMON /EFORCE/ CNEM,CLMEM,CYEM,CLNEM,CLLEM                       6DA01 49
      COMMON /OUTINI/ XNOSEI,YNOSEI,ZNOSEI,XCGI,YCGI,ZCGI,XBASEI,YBASEI,6DA01 50
     1ZBASEI,SLTHC                                                      6DA01 51
C                                                                        6DA01 52
C     FUNCTION STATEMENTS                                                6DA01 53
C                                                                        6DA01 54
      FUNA(X)=RAD*ATAN(BETA*TAN(X/RAD))                                 6DA01 55
C                                                                        6DA01 56
C     FORMAT STATEMENTS                                                  6DA01 57
C                                                                        6DA01 58
  701 FORMAT(1015)                                                      6DA01 59
  702 FORMAT(1H1,23X,40HSIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM//)     6DA01 60
  703 FORMAT(20A4)                                                      6DA01 61
  704 FORMAT(10X,20A4)                                                  6DA01 62
  705 FORMAT(/1H )                                                      6DA01 63
  706 FORMAT(8F10.0)                                                    6DA01 64
  707 FORMAT(10X,26HAIRCRAFT FLIGHT CONDITIONS/15X,17HANGLE OF ATTACK =,6DA01 65
     1F6.2,8H DEGREES/15X,19HFLIGHT PATH ANGLE =,F6.2,8H DEGREES/15X,13H6DA01 66
     2MACH NUMBER =,F5.2/15X,26HFREE STREAM MASS DENSITY =,F11.7,21H SLU6DA01 67
     3GS PER CUBIC FOOT/15X,22HFREE STREAM VELOCITY =,F6.2,16H FEET PER 6DA01 68
     4SECOND//)                                                         6DA01 69
  708 FORMAT(10X,19HFUSELAGE INPUT DATA)                                6DA01 70
  709 FORMAT(15X,17HFUSELAGE LENGTH =,F10.5,5H FEET/15X,16HMAXIMUM RADIU6DA01 71
     1S =,F10.5,5H FEET/)                                               6DA01 72
  710 FORMAT(6E12.4)                                                    6DA01 73
  711 FORMAT(//45X,34HINCOMPRESSIBLE SOURCE DISTRIBUTION)               6DA01 74
  712 FORMAT(1H1,10X,15HWING INPUT DATA)                                6DA01 75
  713 FORMAT(/15X,66HLOCATION OF WING ROOT CHORD LEADING EDGE RELATIVE T6DA01 76
     1O FUSELAGE NOSE/25X,4HXP =,F10.5,5H FEET/25X,4HZP =,F10.5,5H FEET/6DA01 77
     215X,60HINCIDENCE ANGLE OF WING ROOT CHORD RELATIVE TO FUSELAGE AX16DA01 78
     3S/25X,4HIW =,F8.2,8H DEGREES)                                     6DA01 79
  714 FORMAT(1H1,10X,15HRACK INPUT DATA)                                6DA01 80
  715 FORMAT(/15X,13HRACK LENGTH =,F9.5,5H FEET/15X,16HMAXIMUM RADIUS =,6DA01 81
     1F9.5,5H FEET/15X,57HLOCATION OF RACK NOSE RELATIVE TO LOCAL WING L6DA01 82
     2EADING EDGE/20X,3HX =,F9.5,5H FEET/20X,3HZ =,F9.5,5H FEET/15X,48HR6DA01 83
     3ACK INCIDENCE ANGLE RELATIVE TO WING ROOT CHORD/20X,4HIR =,F9.5,8H6DA01 84
     4 DEGREES)                                                         6DA01 85
  716 FORMAT(1H1,10X,12HSTORE NUMBER,I5,21H IS THE STORE EJECTED/)      6DA01 86
  717 FORMAT(15X,31HADDITIONAL INPUT FOR THIS STORE/20X,12HSTORE MASS =,6DA01 87
     1F10.5,6H SLUGS/20X,45HMOMENTS AND PRODUCTS OF INERTIA, SLUG - SQ F6DA01 88
     2T/23X,5HIXX =,F10.5/23X,5HIYY =,F10.5/23X,5HIZZ =,F10.5/23X,5HIYZ 6DA01 89
     3=,F10.5/23X,5HIXZ =,F10.5/23X,5HIXY =,F10.5)                     6DA01 90
  718 FORMAT(20X,22HSTORE MOMENT CENTER IS,F9.5,17H FEET BEHIND NOSE/20X6DA01 91
     1,55HSTORE CENTER OF GRAVITY OFFSET FROM MOMENT CENTER, FEET/23X,6H6DA01 92
     2XBAR =,F9.5/23X,6HYBAR =,F9.5/23X,6HZBAR =,F9.5)                  6DA01 93
  719 FORMAT(20X,47HPOLYNOMIALS SPECIFYING COMPRESSIBLE STORE SHAPE/    6DA01 94
     123X,26HX/L OF END OF EACH SECTION/26X,7HSECTION,5X,3HX/L)         6DA01 95
  720 FORMAT(28X,I2,3X,7F10.5)                                          6DA01 96
  721 FORMAT(23X,51HCOEFFICIENTS OF POLYNOMIALS DESCRIBING EACH SECTION/6DA01 97
     126X,7HSECTION,5X,2HC1,8X,2HC2,8X,2HC3,8X,2HC4,8X,2HC5,8X,2HC6,8X, 6DA01 98
     22HC7)                                                             6DA01 99
  722 FORMAT(20X,18HSEPARATION ASSUMED,F10.5,15H FEET FROM NOSE)        6DA01100
  723 FORMAT(20X,26HAXIAL-FORCE COEFFICIENT IS,F10.5/20X,29HCROSSFLOW-DR6DA01101
     1AG COEFFICIENT IS,F10.5)                                          6DA01102
  724 FORMAT(/20X,33HTHIS STORE HAS A PLANAR EMPENNAGE)                 6DA01103
  725 FORMAT(/20X,36HTHIS STORE HAS A CRUCIFORM EMPENNAGE)              6DA01104
  726 FORMAT(20X,24HTHE EMPENNAGE FORCES ACT,F9.5,17H FEET BEHIND NOSE/ 6DA01105
     120X,50HTHE AVERAGE BODY RADIUS IN THE EMPENNAGE REGION IS,F9.5,5H 6DA01106
     2FEET)                                                             6DA01107
  727 FORMAT(20X,52HTHE TAIL FIN SEMISPAN MEASURED FROM THE BODY AXIS IS6DA01108
     1,F9.5,5H FEET/20X,29HTHE FINS ARE INITIALLY ROLLED,F6.2,41H DEGREE6DA01109
     2S FROM THE VERTICAL AND HORIZONTAL)                               6DA01110
  728 FORMAT(20X,27HTHE FIN LIFT-CURVE SLOPE IS,F9.5,11H PER RADIAN)    6DA01111
C                                                                        6DA01112
C     CONSTANTS                                                          6DA01113
C                                                                        6DA01114
      NMAX=100                                                          6DA01115
      RAD=57.29578                                                      6DA01116
      ACCG=32.174                                                       6DA01117
      DTR=1.0/RAD                                                       6DA01118
      TWOPI=6.2831853                                                   6DA01119
      PI=3.1415927                                                      6DA01120
C                                                                       6DA01121
C     INPUT AND OUTPUT HEADING                                          6DA01122
C                                                                       6DA01123
 1000 READ(5,701) NCARDS                                                6DA01124
      IF (EOF(5)) 2000,2001
 2000 STOP
 2001 CONTINUE
      WRITE(6,702)                                                      6DA01125
      DO 1 J=1,NCARDS                                                   6DA01126
      READ(5,703) HEAD                                                  6DA01127
    1 WRITE(6,704) HEAD                                                 6DA01128
      WRITE(6,705)                                                      6DA01129
C                                                                       6DA01130
C     INPUT AIRCRAFT FLIGHT CONDITIONS                                  6DA01131
C                                                                       6DA01132
      READ(5,706) ALFAC,GAMF,FMACH,RHO,VINF                             6DA01133
      WRITE(6,707) ALFAC,GAMF,FMACH,RHO,VINF                            6DA01134
      BETASQ=1.0-FMACH**2                                               6DA01135
      BETA=SQRT(BETASQ)                                                 6DA01136
      ALFACR=ALFAC*DTR                                                  6DA01137
      ALFAI=FUNA(ALFAC)                                                 6DA01138
      ALFAIR=ALFAI/RAD                                                  6DA01139
C                                                                       6DA01140
C     INPUT INDICES SPECIFYING WHAT AIRCRAFT COMPONENTS ARE PRESENT     6DA01141
```

(a) Page 1.

Figure 10.- Listing of six-degree-of-freedom trajectory program.

```
C                                                                       6DA01142
      READ(5,701) NFU,NPY,NRACK,NSTRS                                   6DA01143
C                                                                       6DA01144
C     INPUT FUSELAGE DATA                                               6DA01145
C                                                                       6DA01146
      IF(NFU.EQ.0) GO TO 10                                             6DA01147
      READ(5,706) FLTHC,FRMAX                                           6DA01148
      WRITE(6,708)                                                      6DA01149
      WRITE(6,709) FLTHC,FRMAX                                          6DA01150
      FLTHI=FLTHC/BETA                                                  6DA01151
      FLTHIS=FLTHI*FLTHI                                                6DA01152
      READ(5,701) NFSOR                                                 6DA01153
      READ(5,710) (FXL(N),N=1,NFSOR)                                    6DA01154
      READ(5,710) (FSOR(N),N=1,NFSOR)                                   6DA01155
      WRITE(6,711)                                                      6DA01156
      CALL SOROUT (NFSOR,FXL,FSOR)                                      6DA01157
      DO 2 N=1,NFSOR                                                    6DA01158
      FXL(N)=-FLTHI*FXL(N)                                              6DA01159
    2 FSOR(N)=FLTHIS*FSOR(N)                                            6DA01160
C                                                                       6DA01161
C     INPUT WING DATA                                                   6DA01162
C                                                                       6DA01163
   10 READ(5,706) XBWOC,ZBWO,WIC                                        6DA01164
      XBWOI=XBWOC/BETA                                                  6DA01165
      WII=FUNA(WIC)                                                     6DA01166
      WICR=WIC/RAD                                                      6DA01167
      CWICR=COS(WICR)                                                   6DA01168
      SWICR=SIN(WICR)                                                   6DA01169
      WIIR=WII/RAD                                                      6DA01170
      ALFWIR=ALFAIR+WIIR                                                6DA01171
      CWIIR=COS(WIIR)                                                   6DA01172
      SWIIR=SIN(WIIR)                                                   6DA01173
      WRITE(6,712)                                                      6DA01174
      WRITE(6,713) XBWOC,ZBWO,WIC                                       6DA01175
      CALL WVLIN        (ALPHAL,CRWI,ALPHL1,CHLOCB,CHLOCL,TANPHI,SUMY,  6DA01176
     1YLOC,SWPC,SWPV,PHI,SINPHI,COSPHI,SWPVV,SW,PVX,PVY,PVZ,PCX,PTLX,    6DA01177
     2PTLY,PTLZ)                                                        6DA01178
      CALL WTHIN        (THETAL,DELTX,CHLOCB,SWPCS,XRC,CHLOCL,Z1,TANPHI,6DA01179
     1FACTOR)                                                           6DA01180
      DO 12 N=1,MS                                                      6DA01181
      SINSWS(N)=SIN(ATAN(SWPCS(N)))                                     6DA01182
   12 COSSWS(N)=COS(ATAN(SWPCS(N)))                                     6DA01183
C                                                                       6DA01184
C     INPUT PYLON DATA                                                  6DA01185
C                                                                       6DA01186
      IF (NPY.EQ.0) GO TO 18                                            6DA01187
      CALL PVLIN        (Z,CRPI,SWPPLI,SWPPTI,XPLEI,XP,YP,ZP,SUMZ,SWPCP,6DA01188
     1SWPVP,SP,PVPX,PVPY,PVPZ,PCPX)                                     6DA01189
      CALL PTHIN        (THETPL,DELTPX,CRPI,Z,SWPPLI,SWPPTI,SWPPCS,XPRC,6DA01190
     1XP,FACTOP)                                                        6DA01191
      DO 15 N=1,MPS                                                     6DA01192
      SINSPS(N)=SIN(ATAN(SWPPCS(N)))                                    6DA01193
   15 COSSPS(N)=COS(ATAN(SWPPCS(N)))                                    6DA01194
      XPC=XP*BETA                                                       6DA01195
      ZP=ZP+Z(1)                                                        6DA01196
      XBPO=XBWOC+XPC*CWICR+ZP*SWICR                                     6DA01197
      XBPOI=XBPO/BETA                                                   6DA01198
      YBPO=YP                                                           6DA01199
      ZBPO=ZBWO+ZP*CWICR-XPC*SWICR                                      6DA01200
      GO TO 20                                                          6DA01201
   18 MP1=M                                                             6DA01202
      MMP=M                                                             6DA01203
      NCP=0                                                             6DA01204
      MSP=0                                                             6DA01205
      MP=0                                                              6DA01206
      NCPS=0                                                            6DA01207
      MPS=0                                                             6DA01208
      IP=0                                                              6DA01209
C                                                                       6DA01210
C     OUTPUT VORTEX LATTICE CONTROL POINT COORDINATES AND TWIST AND     6DA01211
C          CAMBER DISTRIBUTION                                          6DA01212
C                                                                       6DA01213
   20 CALL VLOUT(M,NCW,PCX,BETA,PVY,PVZ,ALPHAL,NPY,MP1,MMP,NCP,PCPY,PVPY6DA01214
     1,PVPZ)                                                            6DA01215
C                                                                       6DA01216
C     OUTPUT THICKNESS DISTRIBUTION                                     6DA01217
C                                                                       6DA01218
      CALL THOUT(MS,THETAL,BETA,NCWS,NPY,MPS,THETPL,NCPS)               6DA01219
C                                                                       6DA01220
C     INPUT RACK DATA                                                   6DA01221
C                                                                       6DA01222
      IF (NRACK.EQ.0) GO TO 30                                          6DA01223
      READ(5,706) RLTHC,RRMAX,XRNC,ZRN,RIC                              6DA01224
      WRITE(6,714)                                                      6DA01225
      WRITE(6,715) RLTHC,RRMAX,XRNC,ZRN,RIC                             6DA01226
      RLTHI=RLTHC/BETA                                                  6DA01227
      RLTHIS=RLTHI*RLTHI                                                6DA01228
      XRNI=XRNC/BETA                                                    6DA01229
      XWRO=XRNI+XLEL(IP)                                                6DA01230
      YWRO=YBPO                                                         6DA01231
      ZWRO=ZLEL(IP)+ZRN                                                 6DA01232
      XWRO=XWRO/BETA                                                    6DA01233
      XBRO=XBWOC+XWRO*CWICR+ZWRO*SWICR                                  6DA01234
      XBRO=XBRO/BETA                                                    6DA01235
      YBRO=YWRO                                                         6DA01236
      ZBRO=ZBWO+ZWRO*CWICR-XWRO*SWICR                                   6DA01237
      RII=FUNA(RIC)                                                     6DA01238
      RIIR=RII/RAD                                                      6DA01239
      CRIIR=COS(RIIR)                                                   6DA01240
      SRIIR=SIN(RIIR)                                                   6DA01241
      READ(5,701) NRSOR                                                 6DA01242
      READ(5,710) (RXL(N),N=1,NRSOR)                                    6DA01243
      READ(5,710) (RSOR(N),N=1,NRSOR)                                   6DA01244
      WRITE(6,711)                                                      6DA01245
      CALL SOROUT (NRSOR,RXL,RSOR)                                      6DA01246
      DO 25 N=1,NRSOR                                                   6DA01247
      RXL(N)=-RLTHI*RXL(N)                                              6DA01248
   25 RSOR(N)=RLTHIS*RSOR(N)                                            6DA01249
   30 CONTINUE                                                          6DA01250
C                                                                       6DA01251
C     INPUT STORE DATA                                                  6DA01252
C                                                                       6DA01253
      IF (NSTRS.EQ.0) GO TO 38                                          6DA01254
      CALL STRIO        (NUMSTR,NSHAPE,SLTHC,SRMAX,XSNC,YSN,ZSN,SIC,SLTHI6DA01255
     1,XSNI,SII,NSSOR,SXL,SSOR,XWSOI,XBWOI,YWSO,ZWSO,ZBWO)              6DA01256
      DO 35 N=1,NSTRS                                                   6DA01257
      SIIR(N)=DTR*SII(N)                                                6DA01258
      CSIIR(N)=COS(SIIR(N))                                             6DA01259
      SSIIR(N)=SIN(SIIR(N))                                             6DA01260
      SIBIR(N)=WIIR+SIIR(N)                                             6DA01261
      CSIBIR(N)=COS(SIBIR(N))                                           6DA01262
      SSIBIR(N)=SIN(SIBIR(N))                                           6DA01263
      SIBCR(N)=(WIC+SIC(N))*DTR                                         6DA01264
      CSIBCR(N)=COS(SIBCR(N))                                           6DA01265
      SSIBCR(N)=SIN(SIBCR(N))                                           6DA01266
      XWSO=XWSOI(N)*BETA                                                6DA01267
      XBSO(N)=XBWOC+XWSO*CWICR+ZWSO(N)*SWICR                            6DA01268
      YBSO(N)=YWSO(N)                                                   6DA01269
      ZBSO(N)=ZBWO+ZWSO(N)*CWICR-XWSO*SWICR                             6DA01270
   35 XBSOI(N)=XBSO(N)/BETA                                             6DA01271
C                                                                       6DA01272
C     COMPUTE VORTEX LATTICE COEFFICIENT MATRIX                         6DA01273
C                                                                       6DA01274
   38 CONTINUE                                                          6DA01275
      CALL VLCOEF       (FVN,PCX,PVX,PVY,PVZ,SWPVV,PHI,SW,COSPHI,SINPHI,6DA01276
     1PVPX,PVPY,PVPZ,SWPVP,SP,PCPX)                                     6DA01277
C                                                                       6DA01278
C     CALCULATE RIGHT HAND SIDE OF SET OF EQUATIONS TO DETERMINE VORTEX 6DA01279
C          STRENGTHS                                                    6DA01280
C                                                                       6DA01281
      CALL VLRHS (PCX,PVY,PVZ,PCPX,PVPY,PVPZ,ALFWIR,ALPHLI,COSPHI,SINPHI6DA01282
     1,CIR,UEI,VEI,WEI)                                                 6DA01283
C                                                                       6DA01284
C     SOLVE FOR VORTICITY DISTRIBUTION                                  6DA01285
```

(b) Page 2.

Figure 10.- Continued.

```
C                                                                       6DA01286
      NN=MMP+1                                                          6DA01287
      IF (IP.EQ.1) NN=M+1                                               6DA01288
      MMM=NN-1                                                          6DA01289
      DO 40 N=1,MMM                                                     6DA01290
   40 FVN(N,NN)=CIR(N)                                                  6DA01291
      CALL INVERS (FVN,1,MMM,100,101)                                   6DA01292
      DO 41 N=1,MMM                                                     6DA01293
   41 CIR(N)=FVN(N,NN)                                                  6DA01294
      IF (IP.NE.1) GO TO 43                                             6DA01295
      DO 42 N=MP1,MMP                                                   6DA01296
      VEI(N)=0.0                                                        6DA01297
   42 CIR(N)=0.0                                                        6DA01298
   43 CONTINUE                                                          6DA01299
C                                                                       6DA01300
C     OUTPUT INTERFERENCE VELOCITIES AND VORTEX STRENGTHS               6DA01301
C                                                                       6DA01302
      CALL VSTOUT (M,NCW,PCX,BETA,BETASQ,UEI,VEI,WEI,CIR,PVY,PVZ,NPY,MP16DA01303
     1,MMP,NCP,PCPX,PVPY,PVPZ)                                          6DA01304
      IF (NSTRS.EQ.0) GO TO 1000                                        6DA01305
C                                                                       6DA01306
C     INPUT ADDITIONAL INFORMATION REQUIRED TO DESCRIBE EJECTED STORE   6DA01307
C                                                                       6DA01308
      READ (5,701) NEJECT,NSEG,NSEGXO,NGAM,NPOLY,NROLL,NEMP,NDAMP       6DA01309
      READ (5,706) SMASS,FIXX,FIYY,FIZZ,FIYZ,FIXZ,FIXY                 6DA01310
      READ (5,706) XMOM,XBAR,YBAR,ZBAR                                  6DA01311
      WRITE (6,716) NEJECT                                              6DA01312
      WRITE (6,717) SMASS,FIXX,FIYY,FIZZ,FIYZ,FIXZ,FIXY                6DA01313
      WRITE (6,718) XMOM,XBAR,YBAR,ZBAR                                 6DA01314
      XMOM=ABS(XMOM)                                                    6DA01315
      READ (5,706) (XEND(J),J=1,NPOLY)                                  6DA01316
      DO 50 J=1,NPOLY                                                   6DA01317
   50 READ (5,706) (COEF(J,K),K=1,7)                                    6DA01318
      WRITE (6,719)                                                     6DA01319
      DO 51 J=1,NPOLY                                                   6DA01320
   51 WRITE (6,720) J,XEND(J)                                           6DA01321
      WRITE (6,721)                                                     6DA01322
      DO 52 J=1,NPOLY                                                   6DA01323
   52 WRITE (6,720) J,(COEF(J,K),K=1,7)                                 6DA01324
C                                                                       6DA01325
C     DETERMINE GEOMETRIC PARAMETERS DESCRIBING STORE                   6DA01326
C                                                                       6DA01327
      DO 53 J=1,NSTRS                                                   6DA01328
      IF (NEJECT-NUMSTR(J)) 53,54,53                                    6DA01329
   54 NEJSTR=J                                                          6DA01330
   53 CONTINUE                                                          6DA01331
      ESTLGC=SLTHC(NEJSTR)                                              6DA01332
      ESTLGI=SLTHI(NEJSTR)                                              6DA01333
      ESTRMX=SRMAX(NEJSTR)                                              6DA01334
      SREF=PI*ESTRMX**2                                                 6DA01335
      REFL=2.0*ESTRMX                                                   6DA01336
      FSEG=NSEG                                                         6DA01337
      DELX=ESTLGC/FSEG                                                  6DA01338
      DELXI=ESTLGI/FSEG                                                 6DA01339
      DX=DELX/2.0                                                       6DA01340
      DXI=DELXI/2.0                                                     6DA01341
      EXSTI(1)=0.0                                                      6DA01342
      EXST(1)=0.0                                                       6DA01343
      NHSEG=2*NSEG+1                                                    6DA01344
      DO 55 J=2,NHSEG                                                   6DA01345
      EXSTI(J)=EXSTI(J-1)+DXI                                           6DA01346
   55 EXST(J)=EXST(J-1)+DX                                              6DA01347
      DO 56 J=2,NHSEG,2                                                 6DA01348
      XXX=EXST(J)/ESTLGC                                                6DA01349
      CALL SHAPE (XXX,NPOLY,XEND,COEF,RK,ELDRDX(J))                     6DA01350
   56 ERAD(J)=ESTLGC*RR                                                 6DA01351
      FSEGXO=NSEGXO                                                     6DA01352
      XSEP=FSEGXO*DELX                                                  6DA01353
      WRITE(6,722) XSEP                                                 6DA01354
      READ (5,706) CA,CDC                                               6DA01355
      WRITE(6,723) CA,CDC                                               6DA01356
      NHSEGO=2*NSEGXO+1                                                 6DA01357
      NASYM=0                                                           6DA01358
      IF (ABS(XBAR).GT.1.0E-05) NASYM=1                                 6DA01359
      IF (ABS(YBAR).GT.1.0E-05) NASYM=1                                 6DA01360
      IF (ABS(ZBAR).GT.1.0E-05) NASYM=1                                 6DA01361
      SAPG=SIN(ALFACR+GAMF*DTR)                                         6DA01362
      CAPG=COS(ALFACR+GAMF*DTR)                                         6DA01363
C                                                                       6DA01364
C     INPUT EMPENNAGE DATA IF EMPENNAGE IS PRESENT                      6DA01365
C                                                                       6DA01366
      CNEM=0.0                                                          6DA01367
      CLMEM=0.0                                                         6DA01368
      CYEM=0.0                                                          6DA01369
      CLNEM=0.0                                                         6DA01370
      CLLEM=0.0                                                         6DA01371
      IF (NEMP.EQ.0) GO TO 57                                           6DA01372
      READ (5,701) IPLNR,MSF                                            6DA01373
      READ (5,706) XTAIL,RADAV,FINSS,PHIROL,CLALPH                      6DA01374
      IF (IPLNR.EQ.1) WRITE (6,724)                                     6DA01375
      IF (IPLNR.EQ.0) WRITE (6,725)                                     6DA01376
      WRITE (6,726) XTAIL,RADAV                                         6DA01377
      WRITE (6,727) FINSS,PHIROL                                        6DA01378
      WRITE (6,728) CLALPH                                              6DA01379
      CALL EMPINI                                                       6DA01380
C                                                                       6DA01381
C     INITIALIZE FOR TRAJECTORY CALCULATION                             6DA01382
C                                                                       6DA01383
   57 VAR(11)=SIBCR(NEJSTR)                                             6DA01384
      VAR(10)=0.0                                                       6DA01385
      VAR(12)=0.0                                                       6DA01386
      READ(5,706) VZERO,VAR(5)                                          6DA01387
      VAR(1)=VZERO*SSIBCR(NEJSTR)                                       6DA01388
      VAR(2)=0.0                                                        6DA01389
      VAR(3)=VZERO*CSIBCR(NEJSTR)                                       6DA01390
      VAR(4)=0.0                                                        6DA01391
      VAR(6)=0.0                                                        6DA01392
      VAR(7)=XBSO(NEJSTR)-XMOM*CSIBCR(NEJSTR)                           6DA01393
      VAR(8)=YBSO(NEJSTR)                                               6DA01394
      VAR(9)=ZBSO(NEJSTR)+XMOM*SSIBCR(NEJSTR)                           6DA01395
      XNOSEI=XBSO(NEJSTR)                                               6DA01396
      YNOSEI=YBSO(NEJSTR)                                               6DA01397
      ZNOSEI=ZBSO(NEJSTR)                                               6DA01398
      XCGI=VAR(7)                                                       6DA01399
      YCGI=VAR(8)                                                       6DA01400
      ZCGI=VAR(9)                                                       6DA01401
      XBASEI=XNOSEI-SLTHC(NEJSTR)*CSIBCR(NEJSTR)                        6DA01402
      YBASEI=YNOSEI                                                     6DA01403
      ZBASEI=ZNOSEI+SLTHC(NEJSTR)*SSIBCR(NEJSTR)                        6DA01404
      READ (5,706) DTIME,TIMEI,TIMEF                                    6DA01405
      NEQ=12                                                            6DA01406
      DDTIME=DTIME                                                      6DA01407
      TIME=TIMEI                                                        6DA01408
      IF (TIME.LE.0.0) GO TO 60                                         6DA01409
      READ (5,706) VAR                                                  6DA01410
      DO 61 J=10,12                                                     6DA01411
   61 VAR(J)=DTR*VAR(J)                                                 6DA01412
   60 NDIFEQ=1                                                          6DA01413
      CALL ADAMS (DTIME,DDTIME, VAR,DVAR,NEQ,NDIFEQ,TIME)               6DA01414
      NOUT=1                                                            6DA01415
C                                                                       6DA01416
C     CALCULATE AERODYNAMIC FORCES AND MOMENTS                          6DA01417
C                                                                       6DA01418
   62 CALL FORCE                                                        6DA01419
      IF (NEMP.EQ.1) CALL EMPFOR                                        6DA01420
      IF (NGAM.EQ.1) CALL DIRCOS(VAR,DC)                                6DA01421
C                                                                       6DA01422
C     CALCULATE ACCELERATIONS                                           6DA01423
C                                                                       6DA01424
C     CALCULATE COEFFICIENT MATRIX                                      6DA01425
C                                                                       6DA01426
      DO 70 J=1,6                                                       6DA01427
      DO 70 K=1,6                                                       6DA01428
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(c) Page 3.

Figure 10.- Continued.

```
   70 FVN(J,K)=0.0                                                      6DA01429
      FVN(1,1)=1.0                                                      6DA01430
      FVN(2,2)=1.0                                                      6DA01431
      FVN(3,3)=1.0                                                      6DA01432
      FVN(4,4)=FIXX                                                     6DA01433
      FVN(5,5)=FIYY                                                     6DA01434
      FVN(6,6)=FIZZ                                                     6DA01435
      FVN(4,5)=-FIXY                                                    6DA01436
      FVN(4,6)=-FIXZ                                                    6DA01437
      FVN(5,6)=-FIYZ                                                    6DA01438
      FVN(5,4)=-FIXY                                                    6DA01439
      FVN(6,4)=-FIXZ                                                    6DA01440
      FVN(6,5)=-FIYZ                                                    6DA01441
      IF (NASYM.EQ.0) GO TO 80                                          6DA01442
      FVN(1,4)=YBAR*DC(1,3)-ZBAR*DC(1,2)                                6DA01443
      FVN(1,5)=ZBAR*DC(1,1)-XBAR*DC(1,3)                                6DA01444
      FVN(1,6)=XBAR*DC(1,2)-YBAR*DC(1,1)                                6DA01445
      FVN(2,4)=YBAR*DC(2,3)-ZBAR*DC(2,2)                                6DA01446
      FVN(2,5)=ZBAR*DC(2,1)-XBAR*DC(2,3)                                6DA01447
      FVN(2,6)=XBAR*DC(2,2)-YBAR*DC(2,1)                                6DA01448
      FVN(3,4)=YBAR*DC(3,3)-ZBAR*DC(3,2)                                6DA01449
      FVN(3,5)=ZBAR*DC(3,1)-XBAR*DC(3,3)                                6DA01450
      FVN(3,6)=XBAR*DC(3,2)-YBAR*DC(3,1)                                6DA01451
      DO 71 J=4,6                                                       6DA01452
      DO 71 K=1,3                                                       6DA01453
   71 FVN(J,K)=SMASS*FVN(K,J)                                           6DA01454
C                                                                       6DA01455
C     CALCULATE RIGHT HAND SIDE                                         6DA01456
C                                                                       6DA01457
   80 GXX=-ACCG*(SAPG*DC(1,1)-CAPG*DC(3,1))                             6DA01458
      GYY=-ACCG*(SAPG*DC(1,2)-CAPG*DC(3,2))                             6DA01459
      GZZ=-ACCG*(SAPG*DC(1,3)-CAPG*DC(3,3))                             6DA01460
      QSTORE=0.5*RHO*VSTORE**2                                          6DA01461
      QSREF=QSTORE*SREF                                                 6DA01462
      QSREFL=QSREF*REFL                                                 6DA01463
      CNORM=CNSB+CNBY+CNCF                                              6DA01464
      CSIDE=CYSB+CYBY+CYCF                                              6DA01465
      CROLL=0.0                                                         6DA01466
      CPITCH=CLMSB+CLMBY+CLMCF                                          6DA01467
      CYAW=CLNSB+CLNBY+CLNCF                                            6DA01468
      IF (NEMP.EQ.0) GO TO 81                                           6DA01469
      CNORM=CNORM+CNEM                                                  6DA01470
      CSIDE=CSIDE+CYEM                                                  6DA01471
      CROLL=CROLL+CLLEM                                                 6DA01472
      CPITCH=CPITCH+CLMEM                                               6DA01473
      CYAW=CYAW+CLNEM                                                   6DA01474
   81 CONTINUE                                                          6DA01475
      CALL INTOST(VAR(1),VAR(2),VAR(3),UU,VV,WW,DC)                     6DA01476
      RONE=GXX-QSREF*CA/SMASS+VAR(6)*VV-VAR(5)*WW                       6DA01477
      RTWO=GYY+QSREF*CSIDE/SMASS+VAR(4)*WW-VAR(6)*UU                    6DA01478
      RTHR=GZZ-QSREF*CNORM/SMASS+VAR(5)*UU-VAR(4)*VV                    6DA01479
      FVN(4,7)=QSREFL*CROLL                                             6DA01480
      FVN(5,7)=QSREFL*CPITCH                                            6DA01481
      FVN(6,7)=QSREFL*CYAW                                              6DA01482
      IF (NASYM.EQ.0) GO TO 85                                          6DA01483
      RONE=RONE+XBAR*(VAR(5)**2+VAR(6)**2)-YBAR*VAR(4)*VAR(5)-ZBAR*VAR(6DA01484
     1)*VAR(6)                                                          6DA01485
      RTWO=RTWO-XBAR*VAR(4)*VAR(5)+YBAR*(VAR(4)**2+VAR(6)**2)-ZBAR*VAR(5DA01486
     1)*VAR(6)                                                          6DA01487
      RTHR=RTHR-XBAR*VAR(4)*VAR(6)-YBAR*VAR(5)*VAR(6)+ZBAR*(VAR(4)**2+VA6DA01488
     1R(5)**2)                                                          6DA01489
      FVN(4,7)=FVN(4,7)-SMASS*(YBAR*(VAR(4)*VV-VAR(5)*UU)-ZBAR*(VAR(6)* 6DA01490
     1UU-VAR(4)*WW))                                                    6DA01491
      FVN(5,7)=FVN(5,7)-SMASS*(ZBAR*(VAR(5)*WW-VAR(6)*VV)-XBAR*(VAR(4)* 6DA01492
     1VV-VAR(5)*UU))                                                    6DA01493
      FVN(6,7)=FVN(6,7)-SMASS*(XBAR*(VAR(6)*UU-VAR(4)*WW)-YBAR*(VAR(5)* 6DA01494
     1WW-VAR(6)*VV))                                                    6DA01495
      FVN(4,7)=FVN(4,7)+SMASS*(GZZ*YBAR-GYY*ZBAR)                       6DA01496
      FVN(5,7)=FVN(5,7)+SMASS*(GXX*ZBAR-GZZ*XBAR)                       6DA01497
      FVN(6,7)=FVN(6,7)+SMASS*(GYY*XBAR-GXX*YBAR)                       6DA01498
   85 FVN(1,7)=RONE*DC(1,1)+RTWO*DC(1,2)+RTHR*DC(1,3)                   6DA01499
      FVN(2,7)=RONE*DC(2,1)+RTWO*DC(2,2)+RTHR*DC(2,3)                   6DA01500
      FVN(3,7)=RONE*DC(3,1)+RTWO*DC(3,2)+RTHR*DC(3,3)                   6DA01501
      FVN(4,7)=FVN(4,7)-VAR(6)*VAR(5)*(FIZZ-FIYY)+(VAR(5)**2-VAR(6)**2)*6DA01502
     1FIYZ+VAR(4)*(VAR(5)*FIXZ-VAR(6)*FIXY)                             6DA01503
      FVN(5,7)=FVN(5,7)-VAR(6)*VAR(4)*(FIXX-FIZZ)+(VAR(6)**2-VAR(4)**2)*6DA01504
     1FIXZ+VAR(5)*(VAR(6)*FIXY-VAR(4)*FIYZ)                             6DA01505
      FVN(6,7)=FVN(6,7)-VAR(6)*VAR(5)*(FIYY-FIXX)+(VAR(4)**2-VAR(5)**2)*6DA01506
     1FIXY+VAR(6)*(VAR(4)*FIYZ-VAR(5)*FIXZ)                             6DA01507
C                                                                       6DA01508
C     SOLVE FOR ACCELERATIONS                                           6DA01509
C                                                                       6DA01510
      CALL INVERS (FVN,1,6,100,101)                                     6DA01511
      DO 86 J=1,6                                                       6DA01512
   86 DVAR(J)=FVN(J,7)                                                  6DA01513
      DO 87 J=7,9                                                       6DA01514
   87 DVAR(J)=VAR(J-6)                                                  6DA01515
      SPHI=SIN(VAR(12))                                                 6DA01516
      CPHI=COS(VAR(12))                                                 6DA01517
      DVAR(10)=(VAR(5)*SPHI+VAR(6)*CPHI)/COS(VAR(11))                   6DA01518
      DVAR(11)=VAR(5)*CPHI-VAR(6)*SPHI                                  6DA01519
      DVAR(12)=VAR(4)+SIN(VAR(11))*DVAR(10)                             6DA01520
C                                                                       6DA01521
C     OUTPUT TRAJECTORY DATA IF AT END OF INTEGRATION STEP              6DA01522
C                                                                       6DA01523
      IF (NOUT.EQ.0) GO TO 91                                           6DA01524
      CALL OUTPUT                                                       6DA01525
      NOUT=0                                                            6DA01526
      IF (TIME+1.0E-05-TIMEF) 91,1000,1000                              6DA01527
C                                                                       6DA01528
C     CALL INTEGRATION ROUTINE                                          6DA01529
C                                                                       6DA01530
   91 CALL ADAMS (DTIME, DDTIME,VAR,DVAR,NEQ,NDIFEQ,TIME)               6DA01531
      IF (NDIFEQ.EQ.1) GO TO 1000                                       6DA01532
      IF (NDIFEQ.GT.7) NOUT=1                                           6DA01533
      GO TO 62                                                          6DA01534
      END                                                               6DA01535
```

```
C     ADAMS INTEGRATION ROUTINE                                         6DA02  1
C                                                                       6DA02  2
      SUBROUTINE ADAMS (H,DS,Y,DY,NEQ,NDIFEQ,S)                         6DA02  3
      DIMENSION Y(12),DY(12)                                            6DA02  4
      DIMENSION Y1(12),DY3(12),Y5(12),E(12),Y3(12),DY1(12),Y2(12),PX(12)6DA02  5
     1,PF(12),DY2(12)                                                   6DA02  6
      DATA RTEST,ATEST,RATIO,FLB/1.42E-01,1.42E-03,100.0,1.0E-04/       6DA02  7
      GO TO (100,200,300,400,500,600,700,800,900),NDIFEQ                6DA02  8
C                                                                       6DA02  9
C     START BY RUNGE-KUTTA                                              6DA02 10
C                                                                       6DA02 11
  100 H=DS+DS                                                           6DA02 12
 1101 JB=1                                                              6DA02 13
      DO 101 I=1,NEQ                                                    6DA02 14
  101 Y1(I)=Y(I)                                                        6DA02 15
  102 SX1=S                                                             6DA02 16
  103 NDIFEQ=2                                                          6DA02 17
      RETURN                                                            6DA02 18
  200 DO 201 I=1,NEQ                                                    6DA02 19
      DY3(I)=DY(I)                                                      6DA02 20
      Y5(I)=Y(I)                                                        6DA02 21
      TEMP=H*DY(I)                                                      6DA02 22
      Y(I)=0.5*TEMP+Y5(I)                                               6DA02 23
  201 E(I)=TEMP                                                         6DA02 24
      S=0.5*H+S                                                         6DA02 25
      NDIFEQ=3                                                          6DA02 26
      RETURN                                                            6DA02 27
  300 DO 301 I=1,NEQ                                                    6DA02 28
      TEMP=H*DY(I)                                                      6DA02 29
      Y(I)=0.5*TEMP+Y5(I)                                               6DA02 30
  301 E(I)=E(I)+2.0*TEMP                                                6DA02 31
```

(d) Page 4.

Figure 10.- Continued.

```
      NDIFEQ=4                                                          6DA02 32
      RETURN                                                            6DA02 33
  400 DO 401 I=1,NEQ                                                    6DA02 34
      TEMP=H*DY(I)                                                      6DA02 35
      Y(I)=Y5(I)+TEMP                                                   6DA02 36
  401 E(I)=E(I)+2.0*TEMP                                                6DA02 37
      S=0.5*H+S                                                         6DA02 38
      NDIFEQ=5                                                          6DA02 39
      RETURN                                                            6DA02 40
  500 DO 501 I=1,NEQ                                                    6DA02 41
  501 Y(I)=(H*DY(I)+E(I))*0.16666667+Y5(I)                              6DA02 42
      GO TO (502,507,509,902),JB                                        6DA02 43
  502 DO 503 I=1,NEQ                                                    6DA02 44
  503 Y3(I)=Y(I)                                                        6DA02 45
      S=S-H                                                             6DA02 46
 5503 H=0.5*H                                                           6DA02 47
      TEMP=S+H                                                          6DA02 48
      IF (TEMP-S) 504,504,505                                           6DA02 49
  504 NDIFEQ=1                                                          6DA02 50
      WRITE (6,750)                                                     6DA02 51
  750 FORMAT(//44H  INTEGRATION INTERVAL HAS BECOME TOO SMALL./62H  WHEN6DA02 52
     1 IT IS ADDED TO INDEPENDENT VARIABLE, NO CHANGE RESULTS.)         6DA02 53
      RETURN                                                            6DA02 54
  505 JB=2                                                              6DA02 55
 5505 DO 506 I=1,NEQ                                                    6DA02 56
  506 Y(I)=Y1(I)                                                        6DA02 57
      GO TO 102                                                         6DA02 58
  507 DO 508 I=1,NEQ                                                    6DA02 59
      DY1(I)=DY3(I)                                                     6DA02 60
  508 Y2(I)=Y(I)                                                        6DA02 61
      JB=3                                                              6DA02 62
      GO TO 103                                                         6DA02 63
  509 S=S-H                                                             6DA02 64
C                                                                       6DA02 65
C     ERROR CHECKING                                                    6DA02 66
C                                                                       6DA02 67
 5509 TEST=0.0                                                          6DA02 68
      DO 510 I=1,NEQ                                                    6DA02 69
      VX4=Y(I)                                                          6DA02 70
      TEMR= ABS(Y3(I)-VX4)                                              6DA02 71
      IF (TEMR.LE.0.0) GO TO 510                                        6DA02 72
      VX4= ABS(VX4)                                                     6DA02 73
      IF (VX4.LE.0.0) GO TO 512                                         6DA02 74
      IF (ABS(Y3(I)).LE.0.0) GO TO 512                                  6DA02 75
C                                                                       6DA02 76
C     CHECK FOR RELATIVE ERROR                                          6DA02 77
C                                                                       6DA02 78
      IF (VX4*RTEST-TEMR) 512,511,511                                   6DA02 79
  511 TEMR=TEMR/VX4                                                     6DA02 80
      GO TO 519                                                         6DA02 81
C                                                                       6DA02 82
C     CHECK FOR ABSOLUTE ERROR                                          6DA02 83
C                                                                       6DA02 84
  512 IF (ATEST-TEMR) 514,514,513                                       6DA02 85
  513 TEMR=TEMR*RATIO                                                   6DA02 86
      GO TO 519                                                         6DA02 87
C                                                                       6DA02 88
C     BOTH TESTS FAIL. HALVE INTEGRATION INTERVAL.                      6DA02 89
C                                                                       6DA02 90
  514 CONTINUE                                                          6DA02 91
  515 S=S-H                                                             6DA02 92
      IF (JB-5) 517,514,516                                             6DA02 93
  516 JB=1                                                              6DA02 94
      GO TO 5505                                                        6DA02 95
  517 DO 518 II=1,NEQ                                                   6DA02 96
  518 Y3(II)=Y2(II)                                                     6DA02 97
      GO TO 5503                                                        6DA02 98
  519 IF (TEST-TEMR) 520,510,510                                        6DA02 99
  520 TEST=TEMR                                                         6DA02100
  510 CONTINUE                                                          6DA02101
C                                                                       6DA02102
C     OUTPUT OF RUNGE-KUTTA                                             6DA02103
C                                                                       6DA02104
      IF (JB-4) 521,802,802                                             6DA02105
  521 NDIFEQ=8                                                          6DA02106
      DO 522 I=1,NEQ                                                    6DA02107
      PX(I)=Y(I)                                                        6DA02108
      PF(I)=DY(I)                                                       6DA02109
  522 Y(I)=Y2(I)                                                        6DA02110
      RETURN                                                            6DA02111
  800 DO 801 I=1,NEQ                                                    6DA02112
      Y(I)=PX(I)                                                        6DA02113
      DY(I)=PF(I)                                                       6DA02114
  801 DY2(I)=DY3(I)                                                     6DA02115
      JB=4                                                              6DA02116
      S=S+H                                                             6DA02117
  802 NDIFEQ=9                                                          6DA02118
      RETURN                                                            6DA02119
  900 IF (JB-5) 103,901,702                                             6DA02120
  901 CON=0.041666667*H                                                 6DA02121
      JB=6                                                              6DA02122
 9901 NDIFEQ=6                                                          6DA02123
      GO TO 600                                                         6DA02124
  902 JB=5                                                              6DA02125
      TEST=FLB                                                          6DA02126
      GO TO 802                                                         6DA02127
C                                                                       6DA02128
C     ADAMS INTEGRATION                                                 6DA02129
C                                                                       6DA02130
  600 DO 601 I=1,NEQ                                                    6DA02131
      Y1(I)=Y(I)                                                        6DA02132
      Y(I)=Y(I)+CON*(55.0*DY(I)-59.0*DY3(I)+37.0*DY2(I)-9.0*DY1(I))     6DA02133
      DY1(I)=DY2(I)                                                     6DA02134
      DY2(I)=DY3(I)                                                     6DA02135
      DY3(I)=DY(I)                                                      6DA02136
  601 Y3(I)=Y(I)                                                        6DA02137
      S=S+H                                                             6DA02138
      NDIFEQ=7                                                          6DA02139
      RETURN                                                            6DA02140
  700 DO 701 I=1,NEQ                                                    6DA02141
  701 Y(I)=Y1(I)+CON*(9.0*DY(I)+19.0*DY3(I)-5.0*DY2(I)+DY1(I))          6DA02142
      GO TO 5509                                                        6DA02143
C                                                                       6DA02144
C     TEST FOR DOUBLING OF INTEGRATION INTERVAL                         6DA02145
C                                                                       6DA02146
  702 IF (TEST-FLB) 703,9901,9901                                       6DA02147
  703 H=4.0*H                                                           6DA02148
      GO TO 1101                                                        6DA02149
      END                                                               6DA02150
```

```
C                                                                       6DA03  1
C     ..................................................................6DA03  2
C                                                                       6DA03  3
C        SUBROUTINE CEL1                                                6DA03  4
C                                                                       6DA03  5
C        PURPOSE                                                        6DA03  6
C           CALCULATE COMPLETE ELLIPTIC INTEGRAL OF FIRST KIND          6DA03  7
C                                                                       6DA03  8
C        USAGE                                                          6DA03  9
C           CALL CEL1(RES,AK,IER)                                       6DA03 10
C                                                                       6DA03 11
C        DESCRIPTION OF PARAMETERS                                      6DA03 12
C           RES   - RESULT VALUE                                        6DA03 13
C           AK    - MODULUS (INPUT)                                     6DA03 14
C           IER   - RESULTANT ERROR CODE WHERE                          6DA03 15
C                     IER=0  NO ERROR                                   6DA03 16
C                     IER=1  AK NOT IN RANGE -1 TO +1                   6DA03 17
C                                                                       6DA03 18
C        REMARKS                                                        6DA03 19
C           FOR AK=+1,-1 THE RESULT IS SET TO 1.E30.                    6DA03 20
```

(e) Page 5.

Figure 10.- Continued.

```
C           FOR MODULUS AK AND COMPLEMENTARY MODULUS CK,                  6DA03 21
C           EQUATION AK*AK+CK*CK=1.0 IS USED.                             6DA03 22
C           AK MUST BE IN THE RANGE -1 TO +1                              6DA03 23
C                                                                         6DA03 24
C         SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                   6DA03 25
C           NONE                                                          6DA03 26
C                                                                         6DA03 27
C         METHOD                                                          6DA03 28
C           DEFINITION                                                    6DA03 29
C           CEL1(AK)=INTEGRAL(1/SQRT((1+T*T)*(1+(CK*T)**2)), SUMMED       6DA03 30
C           OVER T FROM 0 TO INFINITY).                                   6DA03 31
C           EQUIVALENT ARE THE DEFINITIONS                                6DA03 32
C           CEL1(AK)=INTEGRAL(1/((COS(T)SQRT(1+(CK*TAN(T))**2)),SUMMED    6DA03 33
C           OVER T FROM 0 TO PI/2),                                       6DA03 34
C           CEL1(AK)=INTEGRAL(1/SQRT(1-(AK*SIN(T))**2),SUMMED OVER T      6DA03 35
C           FROM 0 TO PI/2), WHERE K=SQRT(1.-CK*CK).                      6DA03 36
C           EVALUATION                                                    6DA03 37
C           LANDENS TRANSFORMATION IS USED FOR CALCULATION.               6DA03 38
C           REFERENCE                                                     6DA03 39
C           R.BULIRSCH, 'NUMERICAL CALCULATION OF ELLIPTIC INTEGRALS      6DA03 40
C           AND ELLIPTIC FUNCTIONS', HANDBOOK SERIES SPECIAL FUNCTIONS,   6DA03 41
C           NUMERISCHE MATHEMATIK VOL. 7, 1965, PP. 78-90.                6DA03 42
C                                                                         6DA03 43
C     ..................................................................6DA03 44
C                                                                         6DA03 45
      SUBROUTINE CEL1(RES,AK,IER)                                         6DA03 46
C                                                                         6DA03 47
      IER=0                                                               6DA03 48
C                                                                         6DA03 49
C     TEST MODULUS                                                        6DA03 50
C                                                                         6DA03 51
      GEO=1.-AK*AK                                                        6DA03 52
      IF(GEO)1,2,3                                                        6DA03 53
    1 IER=1                                                               6DA03 54
      RETURN                                                              6DA03 55
C                                                                         6DA03 56
C     SET RESULT VALUE =OFLOW                                             6DA03 57
C                                                                         6DA03 58
    2 RES=1.E30                                                           6DA03 59
      RETURN                                                              6DA03 60
    3 GEO=SQRT(GEO)                                                       6DA03 61
      ARI=1.                                                              6DA03 62
    4 AARI=ARI                                                            6DA03 63
      TEST=AARI*1.E-4                                                     6DA03 64
      ARI=GEO+ARI                                                         6DA03 65
C                                                                         6DA03 66
C     TEST OF ACCURACY                                                    6DA03 67
C                                                                         6DA03 68
      IF(AARI-GEO-TEST)6,6,5                                              6DA03 69
    5 GEO=SQRT(AARI*GEO)                                                  6DA03 70
      ARI=0.5*ARI                                                         6DA03 71
      GO TO 4                                                             6DA03 72
    6 RES=3.14159265/ARI                                                  6DA03 73
      RETURN                                                              6DA03 74
      END                                                                 6DA03 75
```

```
C                                                                         6DA04  1
C     ..................................................................6DA04  2
C                                                                         6DA04  3
C       SUBROUTINE CEL2                                                   6DA04  4
C                                                                         6DA04  5
C       PURPOSE                                                           6DA04  6
C         COMPUTES THE GENERALIZED COMPLETE ELLIPTIC INTEGRAL OF          6DA04  7
C         SECOND KIND.                                                    6DA04  8
C                                                                         6DA04  9
C       USAGE                                                             6DA04 10
C         CALL CEL2(RES,AK,A,B,IER)                                       6DA04 11
C                                                                         6DA04 12
C       DESCRIPTION OF PARAMETERS                                         6DA04 13
C         RES   - RESULT VALUE                                            6DA04 14
C         AK    - MODULUS (INPUT)                                         6DA04 15
C         A     - CONSTANT TERM IN NUMERATOR                              6DA04 16
C         B     - FACTOR OF QUADRATIC TERM IN NUMERATOR                   6DA04 17
C         IER   - RESULTANT ERROR CODE WHERE                              6DA04 18
C                   IER=0  NO ERROR                                       6DA04 19
C                   IER=1  AK NOT IN RANGE -1 TO +1                       6DA04 20
C                                                                         6DA04 21
C       REMARKS                                                           6DA04 22
C         FOR AK = +1,-1 THE RESULT VALUE IS SET TO 1.E30 IF B IS         6DA04 23
C         POSITIVE, TO -1.E30 IF B IS NEGATIVE.                           6DA04 24
C         SPECIAL CASES ARE                                               6DA04 25
C         K(K) OBTAINED WITH A = 1, B = 1                                 6DA04 26
C         E(K) OBTAINED WITH A = 1, B = CK*CK WHERE CK IS                 6DA04 27
C         COMPLEMENTARY MODULUS.                                          6DA04 28
C         B(K) OBTAINED WITH A = 1, B = 0                                 6DA04 29
C         D(K) OBTAINED WITH A = 0, B = 1                                 6DA04 30
C         WHERE K, E, B, D DEFINE SPECIAL CASES OF THE GENERALIZED        6DA04 31
C         COMPLETE ELLIPTIC INTEGRAL OF SECOND KIND IN THE USUAL          6DA04 32
C         NOTATION, AND THE ARGUMENT K OF THESE FUNCTIONS MEANS           6DA04 33
C         THE MODULUS.                                                    6DA04 34
C                                                                         6DA04 35
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                     6DA04 36
C         NONE                                                            6DA04 37
C                                                                         6DA04 38
C       METHOD                                                            6DA04 39
C         DEFINITION                                                      6DA04 40
C         RES=INTEGRAL((A+B*T*T)/(SQRT((1+T*T)*(1+(CK*T)**2))*(1+T*T))    6DA04 41
C         SUMMED OVER T FROM 0 TO INFINITY).                              6DA04 42
C         EVALUATION                                                      6DA04 43
C         LANDENS TRANSFORMATION IS USED FOR CALCULATION.                 6DA04 44
C         REFERENCE                                                       6DA04 45
C         R.BULIRSCH, 'NUMERICAL CALCULATION OF ELLIPTIC INTEGRALS        6DA04 46
C         AND ELLIPTIC FUNCTIONS', HANDBOOK SERIES SPECIAL FUNCTIONS,     6DA04 47
C         NUMERISCHE MATHEMATIK VOL. 7, 1965, PP. 78-90.                  6DA04 48
C                                                                         6DA04 49
C     ..................................................................6DA04 50
C                                                                         6DA04 51
      SUBROUTINE CEL2(RES,AK,A,B,IER)                                     6DA04 52
C                                                                         6DA04 53
      IER=0                                                               6DA04 54
C                                                                         6DA04 55
C     TEST MODULUS                                                        6DA04 56
C                                                                         6DA04 57
      GEO=1.-AK*AK                                                        6DA04 58
      IF(GEO)1,2,6                                                        6DA04 59
    1 IER=1                                                               6DA04 60
      RETURN                                                              6DA04 61
C                                                                         6DA04 62
C     SET RESULT VALUE = OVERFLOW                                         6DA04 63
C                                                                         6DA04 64
    2 IF(B)3,5,4                                                          6DA04 65
    3 RES=-1.E30                                                          6DA04 66
      RETURN                                                              6DA04 67
    4 RES=1.E30                                                           6DA04 68
      RETURN                                                              6DA04 69
    5 RES=A                                                               6DA04 70
      RETURN                                                              6DA04 71
C                                                                         6DA04 72
```


(f) Page 6.

Figure 10.- Continued.

```
C     COMPUTE INTEGRAL                                                  6DA04  73
C                                                                       6DA04  74
    6 GEO=SQRT(GEO)                                                     6DA04  75
      ARI=1.                                                            6DA04  76
      AA=A                                                              6DA04  77
      AN=A+B                                                            6DA04  78
      W=B                                                               6DA04  79
    7 W=W+AA*GEO                                                        6DA04  80
      W=W+W                                                             6DA04  81
      AA=AN                                                             6DA04  82
      AARI=ARI                                                          6DA04  83
      ARI=GEO+ARI                                                       6DA04  84
      AN=W/ARI+AN                                                       6DA04  85
C                                                                       6DA04  86
C     TEST OF ACCURACY                                                  6DA04  87
C                                                                       6DA04  88
      IF(AARI-GEO-1.E-4*AARI)9,9,8                                      6DA04  89
    8 GEO=SQRT(GEO*AARI)                                                6DA04  90
      GEO=GEO+GEO                                                       6DA04  91
      GO TO 7                                                           6DA04  92
    9 RES=.78539816*AN/ARI                                              6DA04  93
      RETURN                                                            6DA04  94
      END                                                               6DA04  95
```

```
C     SUBROUTINE TO CALCULATE DIRECTION COSINES                         6DA05   1
C                                                                       6DA05   2
      SUBROUTINE DIRCOS (A,D)                                           6DA05   3
      DIMENSION A(1),D(3,3)                                             6DA05   4
      SPSI=SIN(A(10))                                                   6DA05   5
      CPSI=COS(A(10))                                                   6DA05   6
      STHE=SIN(A(11))                                                   6DA05   7
      CTHE=COS(A(11))                                                   6DA05   8
      SPHI=SIN(A(12))                                                   6DA05   9
      CPHI=COS(A(12))                                                   6DA05  10
      D(1,1)=CTHE*CPSI                                                  6DA05  11
      D(1,2)=SPHI*STHE*CPSI-CPHI*SPSI                                   6DA05  12
      D(1,3)=CPHI*STHE*CPSI+SPHI*SPSI                                   6DA05  13
      D(2,1)=CTHE*SPSI                                                  6DA05  14
      D(2,2)=SPHI*STHE*SPSI+CPHI*CPSI                                   6DA05  15
      D(2,3)=CPHI*STHE*SPSI-SPHI*CPSI                                   6DA05  16
      D(3,1)=-STHE                                                      6DA05  17
      D(3,2)=SPHI*CTHE                                                  6DA05  18
      D(3,3)=CPHI*CTHE                                                  6DA05  19
      RETURN                                                            6DA05  20
      END                                                               6DA05  21
```

```
C                                                                       6DA06   1
C     ..................................................................6DA06   2
C                                                                       6DA06   3
C        SUBROUTINE ELI1                                                6DA06   4
C                                                                       6DA06   5
C        PURPOSE                                                        6DA06   6
C           COMPUTES THE ELLIPTIC INTEGRAL OF FIRST KIND                6DA06   7
C                                                                       6DA06   8
C        USAGE                                                          6DA06   9
C           CALL ELI1(RES,X,CK)                                         6DA06  10
C                                                                       6DA06  11
C        DESCRIPTION OF PARAMETERS                                      6DA06  12
C           RES   - RESULT VALUE                                        6DA06  13
C           X     - UPPER INTEGRATION BOUND (ARGUMENT OF ELLIPTIC       6DA06  14
C                   INTEGRAL OF FIRST KIND)                             6DA06  15
C           CK    - COMPLEMENTARY MODULUS                               6DA06  16
C                                                                       6DA06  17
C        REMARKS                                                        6DA06  18
C           MODULUS K = SQRT(1.-CK*CK).                                 6DA06  19
C                                                                       6DA06  20
C        SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                  6DA06  21
C           NONE                                                        6DA06  22
C                                                                       6DA06  23
C        METHOD                                                         6DA06  24
C           DEFINITION                                                  6DA06  25
C           RES=INTEGRAL(1/SQRT((1+T*T)*(1+(CK*T)**2)), SUMMED          6DA06  26
C           OVER T FROM 0 TO X).                                        6DA06  27
C           EQUIVALENT ARE THE DEFINITIONS                              6DA06  28
C           RES=INTEGRAL(1/(COS(T)*SQRT(1+(CK*TAN(T))**2)), SUMMED      6DA06  29
C           OVER T FROM 0 TO ATAN(X)),                                  6DA06  30
C           RES=INTEGRAL(1/SQRT(1-(K*SIN(T))**2), SUMMED OVER           6DA06  31
C           T FROM 0 TO ATAN(X)).                                       6DA06  32
C           EVALUATION                                                  6DA06  33
C           LANDENS TRANSFORMATION IS USED FOR CALCULATION.             6DA06  34
C           REFERENCE                                                   6DA06  35
C           R. BULIRSCH, NUMERICAL CALCULATION OF ELLIPTIC INTEGRALS AND6DA06  36
C                 ELLIPTIC FUNCTIONS.                                   6DA06  37
C                 HANDBOOK SERIES OF SPECIAL FUNCTIONS                  6DA06  38
C                 NUMERISCHE MATHEMATIK VOL. 7, 1965, PP. 78-90.        6DA06  39
C                                                                       6DA06  40
C     ..................................................................6DA06  41
C                                                                       6DA06  42
      SUBROUTINE ELI1(RES,X,CK)                                         6DA06  43
C                                                                       6DA06  44
      IF(X)2,1,2                                                        6DA06  45
    1 RES=0.                                                            6DA06  46
      RETURN                                                            6DA06  47
    2 IF(CK)4,3,4                                                       6DA06  48
    3 RES=ALOG(ABS(X)+SQRT(1.+X*X))                                     6DA06  49
      GOTO 13                                                           6DA06  50
    4 ANGLE=ABS(1./X)                                                   6DA06  51
      GEO=ABS(CK)                                                       6DA06  52
      ARI=1.                                                            6DA06  53
      PIM=0.                                                            6DA06  54
    5 SQGEO=ARI*GEO                                                     6DA06  55
      AARI=ARI                                                          6DA06  56
      ARI=GEO+ARI                                                       6DA06  57
      ANGLE=-SQGEO/ANGLE+ANGLE                                          6DA06  58
      SQGEO=SQRT(SQGEO)                                                 6DA06  59
      IF(ANGLE)7,6,7                                                    6DA06  60
C     REPLACE 0 BY SMALL VALUE                                          6DA06  61
    6 ANGLE=SQGEO*1.E-8                                                 6DA06  62
    7 TEST=AARI*1.E-4                                                   6DA06  63
      IF(ABS(AARI-GEO)-TEST)10,10,8                                     6DA06  64
    8 GEO=SQGEO+SQGEO                                                   6DA06  65
      PIM=PIM+PIM                                                       6DA06  66
      IF(ANGLE)9,5,5                                                    6DA06  67
    9 PIM=PIM+3.1415927                                                 6DA06  68
      GOTO 5                                                            6DA06  69
   10 IF(ANGLE)11,12,12                                                 6DA06  70
   11 PIM=PIM+3.1415927                                                 6DA06  71
   12 RES=(ATAN(ARI/ANGLE)+PIM)/ARI                                     6DA06  72
   13 IF(X)14,15,15                                                     6DA06  73
   14 RES=-RES                                                          6DA06  74
   15 RETURN                                                            6DA06  75
      END                                                               6DA06  76
```

```
C                                                                       6DA07   1
C     ..................................................................6DA07   2
C                                                                       6DA07   3
C        SUBROUTINE ELI2                                                6DA07   4
C                                                                       6DA07   5
C        PURPOSE                                                        6DA07   6
C           COMPUTES THE GENERALIZED ELLIPTIC INTEGRAL OF SECOND KIND   6DA07   7
```

(g) Page 7.

Figure 10.- Continued.

```
C
C       USAGE                                                                  6DA07  8
C          CALL ELI2(R,X,CK,A,B)                                               6DA07  9
C                                                                              6DA07 10
C       DESCRIPTION OF PARAMETERS                                              6DA07 11
C          R      - RESULT VALUE                                               6DA07 12
C          X      - UPPER INTEGRATION BOUND (ARGUMENT OF ELLIPTIC              6DA07 13
C                   INTEGRAL OF SECOND KIND)                                   6DA07 14
C          CK     - COMPLEMENTARY MODULUS                                      6DA07 15
C          A      - CONSTANT TERM IN NUMERATOR                                 6DA07 16
C          B      - QUADRATIC TERM IN NUMERATOR                                6DA07 17
C                                                                              6DA07 18
C       REMARKS                                                                6DA07 19
C          MODULUS K = SQRT(1.-CK*CK).                                         6DA07 20
C          SPECIAL CASES OF THE GENERALIZED ELLIPTIC INTEGRAL OF               6DA07 21
C          SECOND KIND ARE                                                     6DA07 22
C          F(ATAN(X),K) OBTAINED WITH A=1., B=1.                               6DA07 23
C          E(ATAN(X),K) OBTAINED WITH A=1., B=CK*CK.                           6DA07 24
C          B(ATAN(X),K) OBTAINED WITH A=1., B=0.                               6DA07 25
C          D(ATAN(X),K) OBTAINED WITH A=0., B=1.                               6DA07 26
C                                                                              6DA07 27
C       SUBROUTINES AND FUNCTION SUBPROGRAMS REQUIRED                          6DA07 28
C          NONE                                                                6DA07 29
C                                                                              6DA07 30
C       METHOD                                                                 6DA07 31
C          DEFINITION                                                          6DA07 32
C          R=INTEGRAL((A+B*T*T)/(SQRT((1+T*T)*(1+(CK*T)**2))*(1+T*T)),         6DA07 33
C                SUMMED OVER T FROM 0 TO X).                                   6DA07 34
C          EQUIVALENT IS THE DEFINITION                                        6DA07 35
C          R=INTEGRAL((A+(B-A)*(SIN(T))**2)/SQRT(1-(K*SIN(T))**2),             6DA07 36
C                SUMMED OVER T FROM 0 TO ATAN(X)).                             6DA07 37
C          EVALUATION                                                          6DA07 38
C          LANDENS TRANSFORMATION IS USED FOR CALCULATION.                     6DA07 39
C          REFERENCE                                                           6DA07 40
C          R. BULIRSCH, NUMERICAL CALCULATION OF ELLIPTIC INTEGRALS AND        6DA07 41
C                ELLIPTIC FUNCTIONS                                            6DA07 42
C                HANDBOOK SERIES OF SPECIAL FUNCTIONS                          6DA07 43
C                NUMERISCHE MATHEMATIK VOL. 7, 1965, PP. 78-90.                6DA07 44
C                                                                              6DA07 45
C     ...........................................................              6DA07 46
C                                                                              6DA07 47
      SUBROUTINE ELI2(R,X,CK,A,B)                                              6DA07 48
C        TEST ARGUMENT                                                         6DA07 49
      IF(X)2,1,2                                                               6DA07 50
    1 R=0.                                                                     6DA07 51
      RETURN                                                                   6DA07 52
C        TEST MODULUS                                                          6DA07 53
    2 C=0.                                                                     6DA07 54
      D=0.5                                                                    6DA07 55
      IF(CK)7,3,7                                                              6DA07 56
    3 R=SQRT(1.+X*X)                                                           6DA07 57
      R=(A-B)*ABS(X)/R+B*ALOG(ABS(X)+R)                                        6DA07 58
C        TEST SIGN OF ARGUMENT                                                 6DA07 59
    4 R=R+C*(A-B)                                                              6DA07 60
      IF(X)5,6,6                                                               6DA07 61
    5 R=-R                                                                     6DA07 62
    6 RETURN                                                                   6DA07 63
C        INITIALIZATION                                                        6DA07 64
    7 AN=(B+A)*0.5                                                             6DA07 65
      AA=A                                                                     6DA07 66
      R=B                                                                      6DA07 67
      ANG=ABS(1./X)                                                            6DA07 68
      PIM=0.                                                                   6DA07 69
      ISI=0                                                                    6DA07 70
      ARI=1.                                                                   6DA07 71
      GEO=ABS(CK)                                                              6DA07 72
C        LANDEN TRANSFORMATION                                                 6DA07 73
    8 R=AA*GEO+R                                                               6DA07 74
      SGEO=ARI*GEO                                                             6DA07 75
      AA=AN                                                                    6DA07 76
      AARI=ARI                                                                 6DA07 77
C        ARITHMETIC MEAN                                                       6DA07 78
      ARI=GEO+ARI                                                              6DA07 79
C           SUM OF SINE VALUES                                                 6DA07 80
      AN=(R/ARI+AA)*0.5                                                        6DA07 81
      AANG=ABS(ANG)                                                            6DA07 82
      ANG=-SGEO/ANG+ANG                                                        6DA07 83
      PIMA=PIM                                                                 6DA07 84
      IF(ANG)10,9,11                                                           6DA07 85
    9 ANG=-1.E-8*AANG                                                          6DA07 86
   10 PIM=PIM+3.1415927                                                        6DA07 87
      ISI=ISI+1                                                                6DA07 88
   11 AANG=ARI*ARI+ANG*ANG                                                     6DA07 89
      P=D/SQRT(AANG)                                                           6DA07 90
      IF(ISI-4)13,12,12                                                        6DA07 91
   12 ISI=ISI-4                                                                6DA07 92
   13 IF(ISI-2)15,14,14                                                        6DA07 93
   14 P=-P                                                                     6DA07 94
   15 C=C+P                                                                    6DA07 95
      D=D*(AARI-GEO)*0.5/ARI                                                   6DA07 96
      IF(ABS(AARI-GEO)-1.E-4*AARI)17,17,16                                     6DA07 97
   16 SGEO=SQRT(SGEO)                                                          6DA07 98
C        GEOMETRIC MEAN                                                        6DA07 99
      GEO=SGEO+SGEO                                                            6DA07100
      PIM=PIM+PIMA                                                             6DA07101
      ISI=ISI+ISI                                                              6DA07102
      GOTO 8                                                                   6DA07103
C        ACCURACY WAS SUFFICIENT                                               6DA07104
   17 R=(ATAN(ARI/ANG)+PIM)*AN/ARI                                             6DA07105
      C=C+D*ANG/AANG                                                           6DA07106
      GOTO 4                                                                   6DA07107
      END                                                                      6DA07108
                                                                               6DA07109
```

```
C     SUBROUTINE TO CALCULATE EMPENNAGE FORCES                                 6DA0A  1
C                                                                              6DA0A  2
      SUBROUTINE EMPFOR                                                        6DA0A  3
      DIMENSION UTL(11,4),VTL(11,4),WTL(11,4),VN(11,4),SARG(11)                6DA0A  4
      DIMENSION VAR(12),DC(3,3),UT(81),VT(81),WT(81),XBSOI(10),CSIBIR(10       6DA0A  5
     1),ZBSO(10),SSIBIR(10),YBSO(10),ERAD(81),CNX(40),CYX(40),EDROX(81)        6DA0A  6
      COMMON /EFORCE/ CNEM,CLMEM,CYEM,CLNEM,CLLEM                              6DA0A  7
      COMMON /EMPDAT/ FINSS,RADAV,XTAIL,PHIROL,MSF,IPLNR,CLALPH                6DA0A  8
      COMMON/IFORCE/NHSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NHSEGO                  6DA0A  9
      COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBRO1,ZBRO,YBRO,XBSOI,CSIBIR,       6DA0A 10
     1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTORE,XMOM,ESTRMX,CDC,CNBY,CYBY,           6DA0A 11
     2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,EDROX,CNCF,          6DA0A 12
     3CYCF,CLMCF,CLNCF                                                         6DA0A 13
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                                   6DA0A 14
      COMMON /EMPCON/ RFIN(11),YTAIL(11,4),ZTAIL(11,4),FROLE(4),FCONA,         6DA0A 15
     1FCONB,FCONC,CCL3(11),CCL5(11),XTAILI,DYFIN                               6DA0A 16
      DO 1 J=1,4                                                               6DA0A 17
      DO 1 K=1,MSF                                                             6DA0A 18
      UTL(K,J)=0.0                                                             6DA0A 19
      VTL(K,J)=0.0                                                             6DA0A 20
    1 WTL(K,J)=0.0                                                             6DA0A 21
      XXX=XTAIL+XMOM                                                           6DA0A 22
      JMAX=4                                                                   6DA0A 23
      IF (IPLNR.EQ.1) JMAX=2                                                   6DA0A 24
C                                                                              6DA0A 25
C     CALCULATE VELOCITIES IN STORE COORDINATE SYSTEM                          6DA0A 26
C                                                                              6DA0A 27
      DO 2 J=1,JMAX                                                            6DA0A 28
      DO 2 K=1,MSF                                                             6DA0A 29
      YYY=YTAIL(K,J)                                                           6DA0A 30
      ZZZ=ZTAIL(K,J)                                                           6DA0A 31
      CALL STTOIN (XXX,YYY,ZZZ,XI,ETA,ZETA,DC)                                 6DA0A 32
      XB=VAR(7)+XI                                                             6DA0A 33
      XB=XB/BETA                                                               6DA0A 34
      YB=VAR(8)+ETA                                                            6DA0A 35
      ZB=VAR(9)+ZETA                                                           6DA0A 36
```

(h) Page 8.

Figure 10.- Continued.

```
C
C     CALCULATE PERTURBATION VELOCITY FIELD                                    6DA08 37
C                                                                              6DA08 38
      CALL VELFLD (XB,YB,ZB,UTL(K,J),VTL(K,J),WTL(K,J))                        6DA08 39
    2 CONTINUE                                                                 6DA08 40
C                                                                              6DA08 41
C     CALCULATE STORE FREE-STREAM VELOCITY COMPONENTS                          6DA08 42
C                                                                              6DA08 43
      VXI=VINF*COS(ALFACR)                                                     6DA08 44
      VETA=0.0                                                                 6DA08 45
      VZETA=VINF*SIN(ALFACR)                                                   6DA08 46
      IF (NGAM.EQ.1) GO TO 3                                                   6DA08 47
      VXI=VXI+VAR(1)                                                           6DA08 48
      VETA=VETA+VAR(2)                                                         6DA08 49
      VZETA=VZETA+VAR(3)                                                       6DA08 50
    3 VSTORE=SQRT(VXI**2+VETA**2+VZETA**2)                                     6DA08 51
      CALL INTOST (VXI,VETA,VZETA,VX,VY,VZ,DC)                                 6DA08 52
C                                                                              6DA08 53
C     ADD FREE-STREAM COMPONENTS TO PERTURBATION VELOCITIES                    6DA08 54
C     RESULTING VELOCITIES ARE POSITIVE IN -X, +Y, AND -Z DIRECTIONS           6DA08 55
C                                                                              6DA08 56
      VRATIO=VINF/VSTORE                                                       6DA08 57
      DO 4 J=1,JMAX                                                            6DA08 58
      DO 4 K=1,MSF                                                             6DA08 59
      UTL(K,J)=-VRATIO*UTL(K,J)+VX/VSTORE                                      6DA08 60
      VTL(K,J)=+VRATIO*VTL(K,J)-VY/VSTORE                                      6DA08 61
    4 WTL(K,J)=-VRATIO*WTL(K,J)+VZ/VSTORE                                      6DA08 62
C                                                                              6DA08 63
C     ADD IN Q AND R DAMPING                                                   6DA08 64
C                                                                              6DA08 65
      IF (NDAMP.EQ.0) GO TO 6                                                  6DA08 66
      DUM=-XXX/VSTORE                                                          6DA08 67
      DO 5 J=1,JMAX                                                            6DA08 68
      DO 5 K=1,MSF                                                             6DA08 69
      VTL(K,J)=VTL(K,J)+VAR(6)*DUM                                             6DA08 70
    5 WTL(K,J)=WTL(K,J)+VAR(5)*DUM                                             6DA08 71
C                                                                              6DA08 72
C     DETERMINE VELOCITY COMPONENTS NORMAL TO PANELS EXCLUDING                 6DA08 73
C          ROLL DAMPING CONTRIBUTION                                           6DA08 74
C                                                                              6DA08 75
    6 DUM=-1.0                                                                 6DA08 76
      DO 7 J=1,JMAX                                                            6DA08 77
      SPHI=SIN(FROLE(J))                                                       6DA08 78
      CPHI=COS(FROLE(J))                                                       6DA08 79
      DUM=-DUM                                                                 6DA08 80
      DO 7 K=1,MSF                                                             6DA08 81
    7 VN(K,J)=DUM*(WTL(K,J)*SPHI-VTL(K,J)*CPHI)                                6DA08 82
C                                                                              6DA08 83
C     CALCULATE EMPENNAGE NORMAL FORCE, SIDE FORCE, PITCHING MOMENT,           6DA08 84
C          AND YAWING MOMENT                                                   6DA08 85
C                                                                              6DA08 86
      FMSEG=NMSEG                                                              6DA08 87
      DUM=-XTAIL/DX                                                            6DA08 88
      IT=DUM+0.5                                                               6DA08 89
      IT=IT+1                                                                  6DA08 90
      VSO=VT(IT)                                                               6DA08 91
      WSO=WT(IT)                                                               6DA08 92
      ANG=DTR*PHIROL                                                           6DA08 93
      WO=WSO*COS(ANG)+VSO*SIN(ANG)                                             6DA08 94
      VO=-WSO*SIN(ANG)+VSO*COS(ANG)                                            6DA08 95
      A2=RADAV**2                                                              6DA08 96
      DO 8 K=1,MSF                                                             6DA08 97
      AS=(VN(K,1)+VN(K,2))/2.0+WO*A2/(RFIN(K)**2)                              6DA08 98
    8 SARG(K)=AS*CCL3(K)                                                       6DA08 99
      CALL SIMSON (MSF,SARG,DYFIN,SUM)                                         6DA0R100
      CNEM=FCONA*SUM                                                           6DA0R101
      CLMEM=-FCONB*SUM*FCONC                                                   6DA0R102
      CYEM=0.0                                                                 6DA0R103
      CLNEM=0.0                                                                6DA0R104
      IF (IPLNR.EQ.1) GO TO 10                                                 6DA0R105
      DO 9 K=1,MSF                                                             6DA0R106
      BS=(VN(K,3)+VN(K,4))/2.0+VO*A2/(RFIN(K)**2)                              6DA0R107
                                                                               6DA0R108
    9 SARG(K)=BS*CCL3(K)                                                       6DA0R109
      CALL SIMSON (MSF,SARG,DYFIN,SUM)                                         6DA0R110
      CYEM=FCONA*SUM                                                           6DA0R111
      CLNEM=-FCONB*SUM*FCONC                                                   6DA0R112
   10 TA=CNEM                                                                  6DA0R113
      TB=CYEM                                                                  6DA0R114
      CA=COS(ANG)                                                              6DA0R115
      SA=SIN(ANG)                                                              6DA0R116
      CNEM=TA*CA-TB*SA                                                         6DA0R117
      CYEM=TA*SA+TB*CA                                                         6DA0R118
      TA=CLMEM                                                                 6DA0R119
      TB=CLNEM                                                                 6DA0R120
      CLMEM=TA*CA-TB*SA                                                        6DA0R121
      CLNEM=TA*SA+TB*CA                                                        6DA0R122
C                                                                              6DA0R123
C     CALCULATE ROLLING MOMENT                                                 6DA0R124
C                                                                              6DA0R125
      CLLEM=0.0                                                                6DA0R126
      IF (NROLL.EQ.0) RETURN                                                   6DA0R127
      DO 11 K=1,MSF                                                            6DA0R128
      ABU=(VN(K,1)-VN(K,2))/2.0                                                6DA0R129
      IF (NDAMP.GT.0) ABU=ABU+VAR(4)*RFIN(K)/VSTORE                            6DA0R130
      IF (IPLNR.EQ.1) GO TO 12                                                 6DA0R131
      ABU=ABU+(VN(K,3)-VN(K,4))/2.0                                            6DA0R132
      IF (NDAMP.GT.0) ABU=ABU+VAR(4)*RFIN(K)/VSTORE                            6DA0R133
   12 SARG(K)=ABU*CCL5(K)                                                      6DA0R134
   11 CONTINUE                                                                 6DA0R135
      CALL SIMSON (MSF,SARG,DYFIN,SUM)                                         6DA0R136
      CLLEM=-FCONB*SUM                                                         6DA0R137
      RETURN                                                                   6DA0R138
      END                                                                      6DA0R139
```

```
C     SUBROUTINE TO INITIALIZE FOR EMPENNAGE CALCULATION                       6DA09  1
C                                                                              6DA09  2
      SUBROUTINE EMPINI                                                        6DA09  3
      DIMENSION VAR(12),DC(3,3),UT(81),VT(81),WT(81),XBSOI(10),CSIBIR(106DA09  4
     1),ZBSO(10),SSIBIR(10),YBSO(10),ERAD(81),CNX(40),CYX(40),EDRDX(81) 6DA09  5
      COMMON/IFORCE/NMSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NMSEGO                  6DA09  6
      COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBROI,ZBRO,YBRO,XBSOI,CSIBIR,6DA09  7
     1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTORE,XMOM,ESTRMX,CLC,CNBY,CYBY,     6DA09  8
     2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,EDRDX,CNCF,    6DA09  9
     3CYCF,CLMCF,CLNCF                                                        6DA09 10
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                                   6DA09 11
      COMMON /EMPDAT/ FINSS,RADAV,XTAIL,PHIROL,MSF,IPLNR,CLALPH                6DA09 12
      COMMON /EMPCON/ RFIN(11),YTAIL(11,4),ZTAIL(11,4),FROLE(4),FCONA,         6DA09 13
     1FCONB,FCONC,CCL3(11),CCL5(11),XTAIL1,DYFIN                              6DA09 14
C                                                                              6DA09 15
C     LOCATE SPANWISE CONTROL POINTS                                           6DA09 16
C                                                                              6DA09 17
      TA=MSF-1                                                                 6DA09 18
      TB=FINSS-RADAV                                                           6DA09 19
      DYFIN=TB/TA                                                              6DA09 20
      DO 1 J=1,MSF                                                             6DA09 21
      TC=J-1                                                                   6DA09 22
    1 RFIN(J)=RADAV+TC*DYFIN                                                   6DA09 23
C                                                                              6DA09 24
C     LOCATE CONTROL POINTS ON FOUR FINS IN STORE COORDINATE SYSTEM            6DA09 25
C                                                                              6DA09 26
      IF (XTAIL.GT.0.0) XTAIL=-XTAIL                                           6DA09 27
      XTAIL1=XTAIL/BETA                                                        6DA09 28
      FROLE(1)=DTR*(PHIROL+90.0)                                               6DA09 29
      FROLE(2)=DTR*(PHIROL+270.0)                                              6DA09 30
      FROLE(3)=DTR*(PHIROL+180.0)                                              6DA09 31
      FROLE(4)=DTR*(PHIROL)                                                    6DA09 32
      JMAX=4                                                                   6DA09 33
      IF (IPLNR.EQ.1) JMAX=2                                                   6DA09 34
      DO 2 J=1,JMAX                                                            6DA09 35
```


Figure 10.- Continued.

```
      SPHI=SIN(FROLE(J))                                                6DA09 36
      CPHI=COS(FROLE(J))                                                6DA09 37
      DO 2 K=1,MSF                                                      6DA09 38
      YTAIL(K,J)=RFIN(K)*SPHI                                           6DA09 39
    2 ZTAIL(K,J)=-RFIN(K)*CPHI                                          6DA09 40
C                                                                       6DA09 41
C     COMPUTE CONSTANTS                                                 6DA09 42
C                                                                       6DA09 43
      FCONA=CLALPH/(3.1415927*TB*TB)                                    6DA09 44
      FCONB=FCONA/(2.0*ESTRMX)                                          6DA09 45
      FCONC=-XTAIL-XMOM                                                 6DA09 46
      SHS=FINSS**2                                                      6DA09 47
      A4=RADAV**4                                                       6DA09 48
      A2=RADAV**2                                                       6DA09 49
      TOVPI=2.0/3.1415927                                               6DA09 50
      DO 3 J=1,MSF                                                      6DA09 51
      R2=RFIN(J)**2                                                     6DA09 52
      AR6=(SHS*R2-A4)*(SHS-R2)/(SHS*R2)                                 6DA09 53
    3 CCL3(J)=4.0*SQRT(AR6)                                             6DA09 54
      IF (NROLL.EQ.0) RETURN                                            6DA09 55
      IF (IPLNR.EQ.0) GO TO 10                                          6DA09 56
C                                                                       6DA09 57
C     COMPUTE LOADING COEFFICIENTS FOR ROLLING MOMENT CALCULATION       6DA09 58
C                                                                       6DA09 59
C     PLANAR EMPENNAGE                                                  6DA09 60
C                                                                       6DA09 61
      TA=1.0+TOVPI*ACOS(2.0*FINSS*RADAV/(SHS+A2))                       6DA09 62
      TB=(SHS-A2)/(SHS+A2)                                              6DA09 63
      DO 4 J=1,MSF                                                      6DA09 64
      R=RFIN(J)                                                         6DA09 65
      R2=R*R                                                            6DA09 66
      CCL5(J)=TA*(R+A2/R)*CCL3(J)/4.0                                   6DA09 67
      IF (J.EQ.1.OR.J.EQ.MSF) GO TO 4                                   6DA09 68
      TC=(R2+A2)*TB/(R2-A2)                                             6DA09 69
      CCL5(J)=CCL5(J)+TOVPI*((R-A2/R)**2)*ALOG(TC+SQRT(TC*TC-1.0))      6DA09 70
    4 CONTINUE                                                          6DA09 71
      RETURN                                                            6DA09 72
C                                                                       6DA09 73
C     CRUCIFORM EMPENNAGE                                               6DA09 74
C                                                                       6DA09 75
   10 CAPRSQ=(SHS+A4/SHS)/4.0                                           6DA09 76
      CTWGAM=A2/(2.0*CAPRSQ)                                            6DA09 77
      TWGAM=ACOS(CTWGAM)                                                6DA09 78
      STWGAM=SIN(TWGAM)                                                 6DA09 79
      TTWGAM=STWGAM/CTWGAM                                              6DA09 80
      AK1=STWGAM                                                        6DA09 81
      CALL CEL1 (AKK1,STWGAM,IER)                                       6DA09 82
      R2=RFIN(1)**2                                                     6DA09 83
      R4=R2*R2                                                          6DA09 84
      SH4=SHS*SHS                                                       6DA09 85
      TWOTHE=ACOS(SHS*(A4+R4)/(R2*(A4+SH4)))                            6DA09 86
      CCL5(1)=4.0*TOVPI*CAPRSQ*(-CTWGAM*ALOG(CTWGAM)+0.5*AKK1*SIN(2.0*  6DA09 87
     1TWOTHE))                                                          6DA09 88
      CK=SQRT(1.0-AK1*AK1)                                              6DA09 89
      CKCK=CK*CK                                                        6DA09 90
      CALL CEL2 (EPI02K,AK1,1.0,CKCK,IER)                               6DA09 91
      DO 11 J=2,MSF                                                     6DA09 92
      R2=RFIN(J)**2                                                     6DA09 93
      R4=R2*R2                                                          6DA09 94
      CTWTHE=SHS*(A4+R4)/(R2*(A4+SH4))                                  6DA09 95
      TWTHE=ACOS(CTWTHE)                                                6DA09 96
      STWTHE=SIN(TWTHE)                                                 6DA09 97
      TTWTHE=TAN(TWTHE)                                                 6DA09 98
      ARG1=STWTHE/STWGAM                                                6DA09 99
      ARG2=TTWTHE/TTWGAM                                                6DA09100
      ARG3=ASIN(ARG1)                                                   6DA09101
      CCL5(J)=4.0*TOVPI*CAPRSQ*(CTWTHE*0.5*ALOG((1.0+ARG1)/(1.0-ARG1))  6DA09102
     1-CTWGAM*0.5*ALOG((1.0+ARG2)/(1.0-ARG2)))                          6DA09103
      TANA1=TAN(ARG3)                                                   6DA09104
      CALL EL11 (FAK,TANA1,CK)                                          6DA09105
      CALL EL12 (EAK,TANA1,CK,1.0,CKCK)                                 6DA09106
      CCL5(J)=CCL5(J)+2.0*TOVPI*CAPRSQ*(AKK1*SIN(2.0*TWTHE)-2.0*STWGAM  6DA09107
     1*COS(ARG3)*(AKK1*EAK-EPI02K*FAK))                                 6DA09108
   11 CONTINUE                                                          6DA09109
      RETURN                                                            6DA09110
      END                                                               6DA09111
```

```
C     SUBROUTINE TO CALCULATE AERODYNAMIC FORCES AND MOMENTS ON BODY     6DA10  1
C                                                                        6DA10  2
      SUBROUTINE FORCE                                                   6DA10  3
      DIMENSION VAR(12),DC(3,3),UT(81),VT(81),WT(81),FXL(100),FSOR(100),6DA10  4
     1RXL(100),RSOR(100),XBSOI(10),CSIBIR(10),ZBSO(10),SSIBIR(10),      6DA10  5
     2YBSO(10),SXL(100,10),SSOR(100,10),NSSOR(10),SRMAX(10),ERAD(81),   6DA10  6
     3CNX(40),CYX(40),EDRDX(81),SIIR(10),CSIIR(10),SSIIR(10),XWSOI(10), 6DA10  7
     4YWSO(10),ZWSO(10)                                                 6DA10  8
      DIMENSION DUMMY(12)                                                6DA10  9
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS,  6DA10 10
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA10 11
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA10 12
      COMMON /LOCA/ WIIR,CWIIR,SWIIR,XRWOI,ZRWO,XWROI,YWRO,ZWRO,RIIR,   6DA10 13
     1CHIIR,SRIIR,SIIR,CSIIR,SSIIR,XWSOI,YWSO,ZWSO                      6DA10 14
      COMMON /SOURCE/ FXL,FSOR,NFSOR,FRMAX,RXL,RSOR,NRSOR,RRMAX,SXL,SSOR6DA10 15
     1,NSSOR,SRMAX                                                      6DA10 16
      COMMON/IFORCE/NHSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NHSEGO           6DA10 17
      COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBRO1,ZBRO,YBRO,XBSOI,CSIBIR,6DA10 18
     1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTORE,XMOM,ESTRMX,CDC,CNBY,CYBY,    6DA10 19
     2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,EDRDX,CNCF,   6DA10 20
     3CYCF,CLMCF,CLNCF                                                  6DA10 21
      COMMON /FORVEL/ CRIFI,SRIFI,BETASQ                                6DA10 22
      IF (NGAM) 20,20,21                                                6DA10 23
   20 CALL DIRCOS(VAR,DC)                                               6DA10 24
      GO TO 22                                                          6DA10 25
   21 DUMMY(10)=VAR(10)-ATAN(VAR(2)/(VINF*COS(ALFACR)+VAR(1)))          6DA10 26
      DUMMY(11)=VAR(11)+ATAN(VAR(3)/(VINF*COS(ALFACR)+VAR(1)))          6DA10 27
      DUMMY(12)=VAR(12)                                                 6DA10 28
      CALL DIRCOS(DUMMY,DC)                                             6DA10 29
   22 CONTINUE                                                          6DA10 30
      DO 1 J=1,NHSEG                                                    6DA10 31
      UT(J)=0.0                                                         6DA10 32
      VT(J)=0.0                                                         6DA10 33
    1 WT(J)=0.0                                                         6DA10 34
      BETASQ=BETA*BETA                                                  6DA10 35
      IF (NRACK.EQ.0) GO TO 2                                           6DA10 36
      CRIFI=COS(WIIR+RIIR)                                              6DA10 37
      SRIFI=SIN(WIIR+RIIR)                                              6DA10 38
    2 XXI=DXI                                                           6DA10 39
      XX=DX                                                             6DA10 40
      DO 10 N=1,NHSEG                                                   6DA10 41
      XXI=XXI-DXI                                                       6DA10 42
      XX=XX-DX                                                          6DA10 43
C                                                                       6DA10 44
C     LOCATE POINT IN INCOMPRESSIBLE FUSELAGE SYSTEM                    6DA10 45
C                                                                       6DA10 46
      XXX=XX+XMOM                                                       6DA10 47
      CALL STTOIN (XXX,0.0,0.0,XI,ETA,ZETA,DC)                          6DA10 48
      XB=VAR(7)+XI                                                      6DA10 49
      XB=XB/BETA                                                        6DA10 50
      YB=VAR(8)+ETA                                                     6DA10 51
      ZB=VAR(9)+ZETA                                                    6DA10 52
C                                                                       6DA10 53
C     CALCULATE PERTURBATION VELOCITY FIELD                             6DA10 54
C                                                                       6DA10 55
      CALL VELFLD (XB,YB,ZB,UT(N),VT(N),WT(N))                          6DA10 56
   10 CONTINUE                                                          6DA10 57
C                                                                       6DA10 58
C     CALCULATE STORE FREE-STREAM VELOCITY AND COMPONENTS               6DA10 59
C                                                                       6DA10 60
      IF (NGAM) 56,56,55                                                6DA10 61
   55 VXI=VINF*COS(ALFACR)                                              6DA10 62
      VETA=0.0                                                          6DA10 63
      VZETA=VINF*SIN(ALFACR)                                            6DA10 64
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(j) Page 10.

Figure 10.- Continued.

```
      GO TO 57
   56 VXI=VINF*COS(ALFACR)+VAR(1)
      VETA=VAR(2)
      VZETA=VINF*SIN(ALFACR)+VAR(3)
   57 VSTORE=SQRT(VXI**2+VETA**2+VZETA**2)
      CALL INTOST (VXI,VETA,VZETA,VX,VY,VZ,DC)
C
C     ADD FREE-STREAM COMPONENTS TO PERTURBATION VELOCITIES
C     RESULTING VELOCITIES ARE IN -X, +Y, AND -Z DIRECTIONS
C
      VRATIO=VINF/VSTORE
      DO 60 N=1,NHSEG
      UT(N)=-VRATIO*UT(N)+VX/VSTORE
      VT(N)=VRATIO*VT(N)-VY/VSTORE
   60 WT(N)=-VRATIO*WT(N)+VZ/VSTORE
C
C     ADD IN DAMPING TERMS
C
      IF (NDAMP.EQ.0) GO TO 70
      XX=-DX
      DO 65 N=1,NHSEG
      XX=XX+DX
      DUM=(XX-XMOM)/VSTORE
      VT(N)=VT(N)+VAR(6)*DUM
   65 WT(N)=WT(N)+VAR(5)*DUM
C
C     CALCULATE FORCES AND MOMENTS
C
   70 CONA=2.0/(ESTRMX**2)
      CONB=CONA*COC/3.1415927
      XSTOR=-DX
      CNBY=0.0
      CYBY=0.0
      CLMBY=0.0
      CLNBY=0.0
C
C     BUOYANCY FORCES AND MOMENTS
C
      DO 71 N=2,NHSEG,2
      NN=N/2
      XSTOR=XSTOR+DELX
      DUM=XMOM-XSTOR
      CONC=CONA*ERAD(N)**2
      COND=DUM/(2.0*ESTRMX)*DELX
      DCN=CONC*(WT(N+1)-WT(N-1))/DELX
      DCY=CONC*(VT(N+1)-VT(N-1))/DELX
      CNBY=CNBY+DELX*DCN
      CYBY=CYBY+DELX*DCY
      CNX(NN)=DCN
      CYX(NN)=DCY
      CLMBY=CLMBY+COND*DCN
      CLNBY=CLNBY+COND*DCY
   71 CONTINUE
C
C     SLENDER BODY THEORY FORCES AND MOMENTS
C
      CNSB=0.0
      CYSB=0.0
      CLMSB=0.0
      CLNSB=0.0
      XSTOR=-DX
      DO 72 N=2,NHSEG0,2
      XSTOR=XSTOR+DELX
      NN=N/2
      CONC=2.0*CONA*ERAD(N)*EDRDX(N)
      COND=(XMOM-XSTOR)/(2.0*ESTRMX)*DELX
      DCN=CNX(NN)+CONC*WT(N)
      DCY=CYX(NN)+CONC*VT(N)
      CNSB=CNSB+DELX*DCN
      CYSB=CYSB+DELX*DCY
      CNX(NN)=CNX(NN)+DCN
      CYX(NN)=CYX(NN)+DCY
      CLMSB=CLMSB+COND*DCN
      CLNSB=CLNSB+COND*DCY
   72 CONTINUE
C
C     VISCOUS CROSSFLOW FORCES AND MOMENTS
C
      CNCF=0.0
      CYCF=0.0
      CLMCF=0.0
      CLNCF=0.0
      IF (NHSEG.EQ.NHSEG0) GO TO 80
      CONTINUE
      NI=NHSEG0+1
      DO 73 N=NI,NHSEG,2
      VC=SQRT(WT(N)**2+VT(N)**2)
      XSTOR=XSTOR+DELX
      NN=N/2
      CONC=CONB*ERAD(N)*VC
      COND=(XMOM-XSTOR)/(2.0*ESTRMX)*DELX
      DCN=CONC*WT(N)
      DCY=CONC*VT(N)
      CNCF=CNCF+DELX*DCN
      CYCF=CYCF+DELX*DCY
      CNX(NN)=CNX(NN)+DCN
      CYX(NN)=CYX(NN)+DCY
      CLMCF=CLMCF+COND*DCN
      CLNCF=CLNCF+COND*DCY
   73 CONTINUE
   80 CONTINUE
      RETURN
      END
```

```
C     SUBROUTINE TO CALCULATE VORTEX LATTICE FIELD POINT VELOCITIES
C
      SUBROUTINE INFWW (PSII,APHII,XXX,YYY,ZZZ,SNN,FU1,FV1,FW1)
      TOLRNC= 0.00001
      FS=SIN(ATAN(PSII))
      FC=COS(ATAN(PSII))
      FT =FS/FC
      FPC=COS(APHII)
      FPS=SIN(APHII)
      F1 =XXX+SNN*FT
      F2 =YYY+SNN*FPC
      F3 =ZZZ+SNN*FPS
      F4 =XXX-SNN*FT
      F5 =YYY-SNN*FPC
      F6 =ZZZ-SNN*FPS
      FFA=(XXX*FC-(YYY*FPC+ZZZ*FPS)*FS)**2+(ZZZ*FPC-YYY*FPS)**2
      FFB=(F1*F1+F2*F2+F3*F3)**.5
      FFC=(F4*F4+F5*F5+F6*F6)**.5
      FFD=F5*F5+F6*F6
      FFE=F2*F2+F3*F3
      FFF=(F1*FS+F2*FC*FPC+F3*FC*FPS)/FFB-(F4*FS+F5*FC*FPC+F6*FC*FPS)/
     1FFC
C
C
      IF(ABS(FFA).LT.TOLRNC) GO TO 262
      FUONE=(ZZZ*FPC-YYY*FPS)*FC*FFF/FFA
      FVONE= -(ZZZ*FS-XXX*FC*FPS)*FFF/FFA
      FWONE=-(XXX*FC*FPC-YYY*FS)*FFF/FFA
      GO TO 265
  262 FUONE=0.
      FVONE=0.
      FWONE=0.
  265 IF(ABS(FFD).LT.TOLRNC) GO TO 263
C
      FVTWO= F6*(1.-F4/FFC)/FFD
      FWTWO=-F5*(1.-F4/FFC)/FFD
      GO TO 266
  263 FVTWO=0.
      FWTWO=0.
  266 IF(ABS(FFE).LT.TOLRNC) GO TO 264
C
```

(k) Page 11.

Figure 10.- Continued.

```
      FVTHRE=-F3*(1.-F1/FFB)/FFE                                        6DA11 42
      FWTHRE=F2*(1.-F1/FFB)/FFE                                         6DA11 43
C                                                                       6DA11 44
      GO TO 267                                                         6DA11 45
  264 FVTHRE=0.                                                         6DA11 46
      FWTHRE=0.                                                         6DA11 47
  267 FUI=FUONE                                                         6DA11 48
      FVI=FVONE+FVTWO+FVTHRE                                            6DA11 49
      FWI=FWONE+FWTWO+FWTHRE                                            6DA11 50
      RETURN                                                            6DA11 51
      END                                                               6DA11 52
```

```
C     SUBROUTINE TO TRANSFORM FROM INERTIAL TO STORE SYSTEM             6DA12  1
C                                                                       6DA12  2
      SUBROUTINE INTOST (XI,ETA,ZETA,X,Y,Z,DC)                          6DA12  3
      DIMENSION DC(3,3)                                                 6DA12  4
      X=XI*DC(1,1)+ETA*DC(2,1)+ZETA*DC(3,1)                             6DA12  5
      Y=XI*DC(1,2)+ETA*DC(2,2)+ZETA*DC(3,2)                             6DA12  6
      Z=XI*DC(1,3)+ETA*DC(2,3)+ZETA*DC(3,3)                             6DA12  7
      RETURN                                                            6DA12  8
      END                                                               6DA12  9
```

```
C     SUBROUTINE TO SOLVE SIMULTANEOUS EQUATIONS                        6DA13  1
C                                                                       6DA13  2
      SUBROUTINE INVERS(A,NSYS,N,NMAX,MMAX)                             6DA13  3
      DIMENSION A(NMAX,MMAX),X(150)                                     6DA13  4
    5 SIGN=1.0                                                          6DA13  5
      NPI=N+1                                                           6DA13  6
      NMI=N-1                                                           6DA13  7
      NPLSY=N+NSYS                                                      6DA13  8
    9 DO 14 I=1,NMI                                                     6DA13  9
      IPI=I+1                                                           6DA13 10
      MAX=I                                                             6DA13 11
      AMAX=ABS(A(I,I))                                                  6DA13 12
      DO 10 K=IPI,N                                                     6DA13 13
      AKMAX=ABS(A(K,I))                                                 6DA13 14
      IF(AKMAX.LE.AMAX) GO TO 10                                        6DA13 15
      MAX=K                                                             6DA13 16
      AMAX=AKMAX                                                        6DA13 17
   10 CONTINUE                                                          6DA13 18
      IF(AMAX.LT.1.0E-12) GO TO 16                                      6DA13 19
      IF(MAX.EQ.I) GO TO 12                                             6DA13 20
      DO 11 L=I,NPLSY                                                   6DA13 21
      TEMP=A(I,L)                                                       6DA13 22
      A(I,L)=A(MAX,L)                                                   6DA13 23
   11 A(MAX,L)=TEMP                                                     6DA13 24
      SIGN=-SIGN                                                        6DA13 25
   12 DO 14 J=IPI,N                                                     6DA13 26
      IF (A(J,I)) 30,14,30                                              6DA13 27
   30 CONST=-A(J,I)/A(I,I)                                              6DA13 28
      DO 13 L=I,NPLSY                                                   6DA13 29
   13 A(J,L)=A(J,L)+A(I,L)*CONST                                        6DA13 30
   14 CONTINUE                                                          6DA13 31
      DET=0.0                                                           6DA13 32
      TEMP=1.0                                                          6DA13 33
      DO 15 I=1,N                                                       6DA13 34
      IF (A(I,I)) 15,16,15                                              6DA13 35
   15 TEMP=TEMP*A(I,I)                                                  6DA13 36
      DET=SIGN*TEMP                                                     6DA13 37
      GO TO 18                                                          6DA13 38
   16 WRITE(6,100)                                                      6DA13 39
  100 FORMAT(5X,18HMATRIX IS SINGULAR)                                  6DA13 40
      STOP                                                              6DA13 41
   18 DO 21 I=NPI,NPLSY                                                 6DA13 42
      DO 20 KK=1,N                                                      6DA13 43
      K=NPI-KK                                                          6DA13 44
```

```
      X(K)=A(K,I)                                                       6DA13 45
      IF(K.EQ.N) GO TO 20                                               6DA13 46
      J=K                                                               6DA13 47
   19 J=J+1                                                             6DA13 48
      X(K)=X(K)-A(K,J)*X(J)                                             6DA13 49
      IF(J.NE.N) GO TO 19                                               6DA13 50
   20 X(K)=X(K)/A(K,K)                                                  6DA13 51
      DO 21 J=1,N                                                       6DA13 52
   21 A(J,I)=X(J)                                                       6DA13 53
      RETURN                                                            6DA13 54
      END                                                               6DA13 55
```

```
C     SUBROUTINE TO OUTPUT FORCE AND MOMENT DATA AND TRAJECTORY DATA    6DA14  1
C                                                                       6DA14  2
      SUBROUTINE OUTPUT                                                 6DA14  3
      DIMENSION VAR(12),DC(3,3),UT(81),VT(81),WT(81),XBSOI(10),CSIBIR(106DA14  4
     1),ZBSO(10),SSIBIR(10),YBSO(10),ERAD(81),CNX(40),CYX(40),EURDX(81) 6DA14  5
      DIMENSION EXST(81),DVAR(12),SLTHC(10)                             6DA14  6
      COMMON /COUTPT/ TIME,EXST,DVAR,ESTLGC                             6DA14  7
      COMMON/IFORCE/NHSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NHSF60           6DA14  8
      COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBRO1,ZBRO,YBRO,XBSOI,CSIBIR,6DA14  9
     1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTORE,XMOM,ESTRMX,CUC,CNRY,CYBY,    6DA14 10
     2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,EDRDX,CNCF,   6DA14 11
     3CYCF,CLMCF,CLNCF                                                  6DA14 12
      COMMON /EFORCE/ CNEM,CLMEM,CYEM,CLNEM,CLLEM                       6DA14 13
      COMMON /OUTINI/ XNOSEI,YNOSEI,ZNOSEI,XCGI,YCGI,ZCGI,XBASEI,YBASEI,6DA14 14
     1ZBASEI,SLTHC                                                      6DA14 15
  701 FORMAT(1H1,5X,6HTIME =,F8.5,8H SECONDS)                           6DA14 16
  702 FORMAT(/5X,29HFORCE AND MOMENT COEFFICIENTS/25X,2HCN,8X,2HCY,7X,  6DA14 17
     13HCLM,7X,3HCLN,7X,3HCLL/7X,8HBUOYANCY,5X,4F10.5/7X,12HSLENDER BODY6DA14 18
     2,1X,4F10.5/7X,9HCROSSFLOW,4X,4F10.5/7X,9HEMPENNAGE,4X,5F10.5/7X,  6DA14 19
     35HTOTAL,8X,5F10.5)                                                6DA14 20
  703 FORMAT(/5X,31HLOAD AND VELOCITY DISTRIBUTIONS/14X,5HX, FT,6X,3HX/L6DA14 21
     1,5X,6HDCN/DX,4X,6HDCY/DX,5X,4HU/VS,6X,4HV/VS,6X,4HW/VS)           6DA14 22
  704 FORMAT(10X,9F10.5)                                                6DA14 23
  705 FORMAT(/5X,67HLOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIM6DA14 24
     1ENSIONS OF FEET/17X,25HRELATIVE TO FUSELAGE NOSE,9X,28HRELATIVE TO6DA14 25
     2 INITIAL POSITION/20X,2HXF,8X,2HYF,8X,2HZF,11X,6HDEL XF,4X,6HDEL YF6DA14 26
     3F,4X,6HDEL ZF)                                                    6DA14 27
  706 FORMAT(/5X,81HTRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE 6DA14 28
     1IN FUSELAGE COORDINATE SYSTEM/10X,27HRELATIVE TO FUSELAGE MOTION/ 6DA14 29
     215X,3HDXF,7X,3HDYF,7X,3HDZF,6X,4HD2XF,6X,4HD2YF,6X,4HD2ZF)        6DA14 30
  707 FORMAT(/5X,75HROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN 6DA14 31
     1STORE COORDINATE SYSTEM/16X,1HP,9X,1HQ,9X,1HR,7X,4HPDOT,6X,4HQDOT,6DA14 32
     26X,4HRDOT)                                                        6DA14 33
  708 FORMAT(/5X,91HSTORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYS6DA14 34
     1TEM AND RATES OF CHANGE OF THESE ANGLES/10X,56HANGLES IN DEGREES, 6DA14 35
     2RATES OF CHANGE IN RADIANS PER SECOND/15X,3HPSI,6X,5HTHETA,6X,3HPH6DA14 36
     3I,6X,4HDPSI,5X,6HDTHETA,5X,4HDPHI)                                6DA14 37
  709 FORMAT(10X,4HNOSE,1X,3F10.5,5X,3F10.5)                            6DA14 38
  710 FORMAT(10X,4HXMOM,1X,3F10.5,5X,3F10.5)                            6DA14 39
  711 FORMAT(10X,4HBASE,1X,3F10.5,5X,3F10.5)                            6DA14 40
C                                                                       6DA14 41
C     OUTPUT TIME                                                       6DA14 42
C                                                                       6DA14 43
      WRITE (6,701) TIME                                                6DA14 44
C                                                                       6DA14 45
C     OUTPUT FORCES AND MOMENTS                                         6DA14 46
C                                                                       6DA14 47
      CNT=CNBY+CNSB+CNCF+CNEM                                           6DA14 48
      CYT=CYBY+CYSB+CYCF+CYEM                                           6DA14 49
      CLMT=CLMBY+CLMSB+CLMCF+CLMEM                                      6DA14 50
      CLNT=CLNBY+CLNSB+CLNCF+CLNEM                                      6DA14 51
      CLLT=CLLEM                                                        6DA14 52
      WRITE (6,702) CNBY,CYBY,CLMBY,CLNBY,CNSB,CYSB,CLMSB,CLNSB,CNCF,   6DA14 53
     1CYCF,CLMCF,CLNCF,CNEM,CYEM,CLMEM,CLNEM,CLLEM,CNT,CYT,CLMT,CLNT,   6DA14 54
     2CLLT                                                              6DA14 55
C                                                                       6DA14 56
C     OUTPUT LOAD AND VELOCITY DISTRIBUTIONS                            6DA14 57
C                                                                       6DA14 58
```


(1) Page 12.

Figure 10.- Continued.

```
      WRITE (6,703)                                                     6DA14 59
      DO 1 J=2,NHSEG,2                                                  6DA14 60
      K=J/2                                                             6DA14 61
      XL=EXST(J)/ESTLOC                                                 6DA14 62
    1 WRITE (6,704) EXST(J),XL,CNX(K),CYX(K),UT(J),VT(J),WT(J)          6DA14 63
C                                                                       6DA14 64
C     CALCULATE AND OUTPUT STORE LOCATION (NOSE, MOMENT CENTER,         6DA14 65
C         AND BASE) IN FUSELAGE COORDINATE SYSTEM                       6DA14 66
C                                                                       6DA14 67
      XXX=XMOM                                                          6DA14 68
      CALL STTOIN (XXX,0.0,0.0,XI,ETA,ZETA,DC)                          6DA14 69
      XNOSE=VAR(7)+XI                                                   6DA14 70
      YNOSE=VAR(8)+ETA                                                  6DA14 71
      ZNOSE=VAR(9)+ZETA                                                 6DA14 72
      DXN=XNOSE-XNOSEI                                                  6DA14 73
      DYN=YNOSE-YNOSEI                                                  6DA14 74
      DZN=ZNOSE-ZNOSEI                                                  6DA14 75
      XXX=-(SLTHC(NEJSTR)-XMOM)                                         6DA14 76
      CALL STTOIN (XXX,0.0,0.0,XI,ETA,ZETA,DC)                          6DA14 77
      XBASE=VAR(7)+XI                                                   6DA14 78
      YBASE=VAR(8)+ETA                                                  6DA14 79
      ZBASE=VAR(9)+ZETA                                                 6DA14 80
      DXB=XBASE-XBASEI                                                  6DA14 81
      DYB=YBASE-YBASEI                                                  6DA14 82
      DZB=ZBASE-ZBASEI                                                  6DA14 83
      DXCG=VAR(7)-XCGI                                                  6DA14 84
      DYCG=VAR(8)-YCGI                                                  6DA14 85
      DZCG=VAR(9)-ZCGI                                                  6DA14 86
      WRITE (6,705)                                                     6DA14 87
      WRITE (6,709) XNOSE,YNOSE,ZNOSE,DXN,DYN,DZN                       6DA14 88
      WRITE (6,710) VAR(7),VAR(8),VAR(9),DXCG,DYCG,DZCG                 6DA14 89
      WRITE (6,711) XBASE,YBASE,ZBASE,DXB,DYB,DZB                       6DA14 90
C                                                                       6DA14 91
C     OUTPUT STORE VELOCITIES                                           6DA14 92
C                                                                       6DA14 93
      WRITE (6,706)                                                     6DA14 94
      WRITE (6,704) VAR(1),VAR(2),VAR(3),DVAR(1),DVAR(2),DVAR(3)        6DA14 95
C                                                                       6DA14 96
C     OUTPUT STORE ACCELERATIONS                                        6DA14 97
C                                                                       6DA14 98
      WRITE (6,707)                                                     6DA14 99
      WRITE (6,704) VAR(4),VAR(5),VAR(6),DVAR(4),DVAR(5),DVAR(6)        6DA14100
C                                                                       6DA14101
C     OUTPUT STORE ANGULAR ORIENTATION                                  6DA14102
C                                                                       6DA14103
      PSI=57.29578*VAR(10)                                              6DA14104
      THA=57.29578*VAR(11)                                              6DA14105
      PHI=57.29578*VAR(12)                                              6DA14106
      WRITE (6,708)                                                     6DA14107
      WRITE (6,704) PSI,THA,PHI,DVAR(10),DVAR(11),DVAR(12)              6DA14108
      RETURN                                                            6DA14109
      END                                                               6DA14110
```

```
C     SUBROUTINE TO INPUT PYLON THICKNESS DATA AND LAY OUT STRIPS       6DA15  1
C                                                                       6DA15  2
      SUBROUTINE PTHIN (THETPL,DELTPX,CRPI,Z,SWPPLI,SWPPTI,SWPPCS,XPRC, 6DA15  3
     1XP,FACTOP)                                                        6DA15  4
      DIMENSION THETPL(1),DELTPX(1),SWPPCS(1),XPRC(1),FACTOP(1),Z(1)    6DA15  5
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA15  6
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA15  7
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA15  8
C                                                                       6DA15  9
C     FORMAT STATEMENTS                                                 6DA15 10
C                                                                       6DA15 11
C                                                                       6DA15 12
  701 FORMAT(10I5)                                                      6DA15 13
  702 FORMAT(8F10.0)                                                    6DA15 14
  703 FORMAT(//14X,I4,49H THICKNESS PANELS ARE TO BE LAID OUT ON THE PYL6DA15 14
     1ON/20X,I3,20H CHORDWISE ROWS WITH,I3,12H IN EACH ROW/21X,43HTHE CH6DA15 15
     2ORDWISE ROWS COINCIDE WITH THOSE USED/21X,21HIN THE VORTEX LATTICE6DA15 16
     3//)                                                               6DA15 17
      READ (5,701) NCPS,NUNIP                                           6DA15 18
      MPS=NCPS*MSP                                                      6DA15 19
      WRITE (6,703) MPS,MSP,NCPS                                        6DA15 20
      IF (NUNIP.NE.0) GO TO 5                                           6DA15 21
      MN=0                                                              6DA15 22
      DO 1 JNP=1,MPS,NCPS                                               6DA15 23
      MN=MN+NCPS                                                        6DA15 24
    1 READ (5,702)(THETPL(JP),JP=JNP,MN)                               6DA15 25
      GO TO 10                                                          6DA15 26
    5 READ (5,702)(THETPL(JP),JP=1,NCPS)                               6DA15 27
      DO 6 J=2,MSP                                                      6DA15 28
      JJ=(J-1)*NCPS                                                     6DA15 29
      DO 6 K=1,NCPS                                                     6DA15 30
      KK=JJ+K                                                           6DA15 31
    6 THETPL(KK)=THETPL(K)                                              6DA15 32
   10 CONTINUE                                                          6DA15 33
      DO 8121 JP=1,MPS                                                  6DA15 34
 8121 THETPL(JP)=THETPL(JP)*BETA                                        6DA15 35
C                                                                       6DA15 36
C     LAY-OUT SPANWISE STRIPS ON THE INCOMPRESSIBLE PYLON               6DA15 37
C                                                                       6DA15 38
C                                                                       6DA15 39
      E=NCPS                                                            6DA15 40
      DO 602 K=2,KMAX                                                   6DA15 41
      DELTPX(K)=(CRPI*((Z(K)+Z(K-1))/2.0-Z(1))*(SWPPLI-SWPPTI))/E       6DA15 42
      DO 721 JPC=1,NCPS                                                 6DA15 43
      JPS=(K-2)*NCPS+JPC                                                6DA15 44
      S=JPC                                                             6DA15 45
      SWPPCS(JPS)=SWPPLI-((S-0.5)/E)*(SWPPLI-SWPPTI)                    6DA15 46
      XPRC(JPS)=XP+((S-0.5)/E)*CRPI                                     6DA15 47
      COSSWP=COS(ATAN(SWPPCS(JPS)))                                     6DA15 48
      FACTOP(JPS)=(THETPL(JPS)*DELTPX(K)*COSSWP)/TWOPI                  6DA15 49
  721 CONTINUE                                                          6DA15 50
  602 CONTINUE                                                          6DA15 51
      RETURN                                                            6DA15 52
      END
```

```
C     SUBROUTINE TO INPUT PYLON VORTEX LATTICE DATA AND LAY OUT VORTICES6DA16  1
C                                                                       6DA16  2
      SUBROUTINE PVLIN (Z,CRPI,SWPPLI,SWPPTI,XPLE1,XP,YP,ZP,SUMZ,SWPCP, 6DA16  3
     1SWPVP,SP,PVPX,PVPY,PVPZ,PCPX)                                     6DA16  4
      DIMENSION Z(1),SUMZ(1),SWPCP(1),SWPVP(1),SP(1),PVPX(1),PVPY(1),   6DA16  5
     1PVPZ(1),PCPX(1)                                                   6DA16  6
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA16  7
     11),XLEL(31),ZLEL(31)                                              6DA16  8
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA16  9
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA16 10
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA16 11
      COMMON /PYLON/ PSIPLE,PSIPTE,CRP,M,XPLE,SWPPLE,SWPPTE             6DA16 12
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA16 13
     1,SWPWTI,XLEL,ZLEL                                                 6DA16 14
C                                                                       6DA16 15
C     FORMAT STATEMENT                                                  6DA16 16
C                                                                       6DA16 17
  701 FORMAT(10I5)                                                      6DA16 18
  702 FORMAT(8F10.0)                                                    6DA16 19
  703 FORMAT(15,7F10.0)                                                 6DA16 20
  704 FORMAT(1H1,10X,16HPYLON INPUT DATA)                               6DA16 21
  705 FORMAT(/15X,41HLEADING EDGE OF PYLON ROOT CHORD IS AT X=,F10.5,45H6DA16 22
     1 FEET (MEASURED FROM LOCAL WING LEADING EDGE)/15X,23HSPANWISE LOCA6DA16 23
     2TION IS Y=,F10.5,5H FEET/15X,11HROOTCHORD =,F10.5,5H FEET/15X,8HHE6DA16 24
     3IGHT =,F10.5,5H FEET/15X,26HLEADING EDGE SWEEP ANGLE =,F10.5,8H DE6DA16 25
     4GREES/15X,27HTRAILING EDGE SWEEP ANGLE =,F10.5,8H DEGREES)        6DA16 26
  706 FORMAT(//14X,I4,41H VORTICES ARE TO BE LAID OUT ON THE PYLON/20X,I6DA16 27
     13,20H CHORDWISE ROWS WITH,I3,12H IN EACH ROW)                     6DA16 28
```


(m) Page 13.

Figure 10.- Continued.

```
  707 FORMAT(/15X,42HSPANWISE LOCATIONS OF TRAILING VORTEX LEGS//20X,1HK6DA16 29
     1,9X,1HZ/2&X,4HFEET)                                          6DA16 30
  708 FORMAT(18X,I3,F14.5)                                         6DA16 31
      READ (5,703) IP,PSIPLE,PSIPTE,CRP,H,XPLE                     6DA16 32
      WRITE (6,704)                                                6DA16 33
      CRP=ABS(CRP)                                                 6DA16 34
      H=ABS(H)                                                     6DA16 35
      WRITE (6,705) XPLE,Y(IP),CRP,H,PSIPLE,PSIPTE                 6DA16 36
      READ (5,701) NCP,MSP                                         6DA16 37
      MP=NCP*MSP                                                   6DA16 38
      WRITE (6,706) MP,MSP,NCP                                     6DA16 39
      MP1=M+1                                                      6DA16 40
      MMP=M+MP                                                     6DA16 41
      KMAX=MSP+1                                                   6DA16 42
      DO 1 J=1,KMAX                                                6DA16 43
    1 READ (5,703) K,Z(K)                                          6DA16 44
      WRITE (6,707)                                                6DA16 45
      DO 2 K=1,KMAX                                                6DA16 46
    2 WRITE (6,708) K,Z(K)                                         6DA16 47
      SWPPLE=TAN(PSIPLE*DTR)                                       6DA16 48
      SWPPTE=TAN(PSIPTE*DTR)                                       6DA16 49
      CRPI=CRP/BETA                                                6DA16 50
      SWPPLI=SWPPLE/BETA                                           6DA16 51
      SWPPTI=SWPPTE/BETA                                           6DA16 52
      XPLEI=XPLE/BETA                                              6DA16 53
      PHIP=-1.5707963                                              6DA16 54
C                                                                  6DA16 55
C     LAY OUT HORSESHOE VORTEX BOUNDLEG MIDPOINTS AND CONTROL POINTS6DA16 56
C     COORDINATES ON THE INCOMPRESSIBLE PYLON                      6DA16 57
C                                                                  6DA16 58
C     DETERMINE PYLON ROOTCHORD NOSE COORDINATES IN WING COORDINATE6DA16 59
C     SYSTEM                                                       6DA16 60
C                                                                  6DA16 61
      XP=XLEL(IP)+XPLEI                                            6DA16 62
      YP=Y(IP)                                                     6DA16 63
      ZP=ZLEL(IP)                                                  6DA16 64
      E=NCP                                                        6DA16 65
      DO 801 K=2,KMAX                                              6DA16 66
      SUMZ(K)=(Z(K)+Z(K-1))/2.0                                    6DA16 67
      DO 820 JRP=1,NCP                                             6DA16 68
      B=JRP                                                        6DA16 69
      SWPCP(JRP)=SWPPLI-((B-0.25)/E)*(SWPPLI-SWPPTI)               6DA16 70
      JP=(K-2)*NCP+JRP+M                                           6DA16 71
      JPP=JP+M                                                     6DA16 72
      SWPVP(JPP)=SWPPLI-((B-0.75)/E)*(SWPPLI-SWPPTI)               6DA16 73
      SP(JPP)=(Z(K)-Z(K-1))/2.0                                    6DA16 74
      PVPX(JPP)=XP-((B-0.75)*(CRPI/E))-(SUMZ(K)-Z(1))*SWPVP(JPP)   6DA16 75
      PVPY(JPP)=YP                                                 6DA16 76
      PVPZ(JPP)=ZP+SUMZ(K)                                         6DA16 77
      PCPX(JPP)=XP-((B-0.25)*(CRPI/E))-(SUMZ(K)-Z(1))*SWPCP(JRP)   6DA16 78
  820 CONTINUE                                                     6DA16 79
  801 CONTINUE                                                     6DA16 80
      RETURN                                                       6DA16 81
      END                                                          6DA16 82
```

```
C     SUBROUTINE TO CALCULATE SHAPE                                6DA17  1
C                                                                  6DA17  2
      SUBROUTINE SHAPE (X,NS,XE,C,R,DRDX)                          6DA17  3
      DIMENSION XE(7),C(7,7)                                       6DA17  4
      DO 1 K=1,NS                                                  6DA17  5
      XL=XE(K)                                                     6DA17  6
      J=K                                                          6DA17  7
      IF (X.LE.XL) GO TO 2                                         6DA17  8
    1 CONTINUE                                                     6DA17  9
    2 R=C(J,1)+X*C(J,5)+X*X*C(J,6)                                 6DA17 10
      ARG=X*X*C(J,2)+X*C(J,3)+C(J,4)                               6DA17 11
      DRDX=C(J,5)+2.0*X*C(J,6)                                     6DA17 12
      IF (ARG.LE.0.0) RETURN                                       6DA17 13
      R=R+SQRT(ARG)*C(J,7)                                         6DA17 14
      DRDX=DRDX+(2.0*X*C(J,2)+C(J,3))/(2.0*SQRT(ARG))*C(J,7)       6DA17 15
      RETURN                                                       6DA17 16
      END                                                          6DA17 17
```

```
C     SIMPSON RULE SUBROUTINE                                      6DA18  1
      SUBROUTINE SIMSON(N,F,DX,SUM)                                6DA18  2
      DIMENSION F(101)                                             6DA18  3
      SUM=F(1)+F(N)                                                6DA18  4
      DO 1 I=2,N,2                                                 6DA18  5
    1 SUM=SUM+4.0*F(I)                                             6DA18  6
      M=N-2                                                        6DA18  7
      DO 2 I=3,M,2                                                 6DA18  8
    2 SUM=SUM+2.0*F(I)                                             6DA18  9
      SUM=DX*SUM/3.0                                               6DA18 10
      RETURN                                                       6DA18 11
      END                                                          6DA18 12
```

```
C     SUBROUTINE TO OUTPUT SOURCE DISTRIBUTION                     6DA19  1
C                                                                  6DA19  2
      SUBROUTINE SOROUT (N,X,S)                                    6DA19  3
      DIMENSION X(1),S(1)                                          6DA19  4
  700 FORMAT(/15X,3HX/L,2X,8(1PE12.5))                             6DA19  5
  701 FORMAT(15X,5HQ*(K),8(1PE12.5))                               6DA19  6
      NA=N/8                                                       6DA19  7
      NB=8*NA                                                      6DA19  8
      IF (NB.LT.N) NA=NA+1                                         6DA19  9
      DO 1 K=1,NA                                                  6DA19 10
      NB=8*(K-1)+1                                                 6DA19 11
      NC=NB+7                                                      6DA19 12
      IF (NC.GT.N ) NC=N                                           6DA19 13
      WRITE (6,700) (X(L),L=NB,NC)                                 6DA19 14
    1 WRITE (6,701) (S(L),L=NB,NC)                                 6DA19 15
      RETURN                                                       6DA19 16
      END                                                          6DA19 17
```

```
C     SUBROUTINE TO INPUT AND OUTPUT STORE DATA                    6DA20  1
C                                                                  6DA20  2
      SUBROUTINE STRIO (NUMSTR,NSHAPE,SLTHC,SRMAX,XSNC,YSN,ZSN,SIC,SLTHI6DA20  3
     1,XSNI,SII,NSSOR,SXL,SSOR,XWSOI,XRWOI,YWSO,ZWSO,ZRWO)         6DA20  4
      DIMENSION NUMSTR(1),NSHAPE(1),SLTHC(1),SRMAX(1),XSNC(1),YSN(1),  6DA20  5
     1ZSN(1),SIC(1),SLTHI(1),XSNI(1),SII(1),NSSOR(1),SXL(100,1),   6DA20  6
     2SSOR(100,1),XWSOI(1),YWSO(1),ZWSO(1)                        6DA20  7
      DIMENSION DUMX(100),DUMY(100)                                6DA20  8
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA20  9
     11),XLEL(31),ZLEL(31)                                        6DA20 10
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA20 11
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                6DA20 12
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                       6DA20 13
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA20 14
     1,SWPWTI,XLEL,ZLEL                                           6DA20 15
  701 FORMAT(2I5,7F10.0)                                           6DA20 16
  702 FORMAT(1H1,10X,16HSTORE INPUT DATA)                          6DA20 17
  703 FORMAT(/40X,36HMAXIMUM   STORE LOCATION RELATIVE TO,6X,9HINCIDENCE6DA20 18
     1/15X,20HSTORE SHAPE   LENGTH,5X,6HRADIUS,4X,24HLOCAL WING CHORD LE6DA20 19
     2ADING EDGE,5X,5HANGLE/17X,2HNO,4X,2HNO,6X,2HFT,9X,2HFT,8X,5HX, FT,6DA20 20
     36X,5HY, FT,6X,5HZ, FT,6X,5HDEG)                             6DA20 21
  704 FORMAT(15X,2I5,6F11.5)                                       6DA20 22
```

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Figure 10.- Continued.

```
  705 FORMAT(//15X,32HSOURCE DISTRIBUTION FOR SHAPE NO,I3)                  6DA20 23
  706 FORMAT(6E12.5)                                                        6DA20 24
  707 FORMAT(////15X,45HSOURCE DISTRIBUTIONS NOT INPUT FOR ALL STORES)      6DA20 25
  708 FORMAT(/45X,34HINCOMPRESSIBLE SOURCE DISTRIBUTION)                    6DA20 26
      DO 1 J=1,NSTRS                                                        6DA20 27
      READ (5,701) NUMSTR(J),NSHAPE(J),SLTHC(J),SRMAX(J),XSNC(J),YSN(J),   6DA20 28
     1ZSN(J),SIC(J)                                                         6DA20 29
      SLTHI(J)=SLTHC(J)/BETA                                                6DA20 30
      XSNI(J)=XSNC(J)/BETA                                                  6DA20 31
    1 SII(J)=RAD*ATAN(BETA*TAN(SIC(J)/RAD))                                 6DA20 32
      WRITE (6,702)                                                         6DA20 33
      WRITE(6,703)                                                          6DA20 34
      DO 2 J=1,NSTRS                                                        6DA20 35
      WRITE(6,704) NUMSTR(J),NSHAPE(J),SLTHC(J),SRMAX(J),XSNC(J),YSN(J)     6DA20 36
     1,ZSN(J),SIC(J)                                                        6DA20 37
    2 CONTINUE                                                              6DA20 38
      NCOUNT=0                                                              6DA20 39
      READ(5,701) NSHPT                                                     6DA20 40
      DO 3 J=1,NSHPT                                                        6DA20 41
      READ(5,701) MSHAPE,MSOR                                               6DA20 42
      READ(5,706) (DUMX(K),K=1,MSOR)                                        6DA20 43
      READ(5,706) (DUMQ(K),K=1,MSOR)                                        6DA20 44
      WRITE(6,705) MSHAPE                                                   6DA20 45
      WRITE(6,708)                                                          6DA20 46
      CALL SOROUT (MSOR,DUMX,DUMQ)                                          6DA20 47
      DO 4 K=1,NSTRS                                                        6DA20 48
      IF (MSHAPE.NE.NSHAPE(K)) GO TO 4                                      6DA20 49
      DA=SLTHI(K)                                                           6DA20 50
      DB=DA*DA                                                              6DA20 51
      NSSOR(K)=MSOR                                                         6DA20 52
      DO 5 L=1,MSOR                                                         6DA20 53
      SXL(L,K)=-DA*DUMX(L)                                                  6DA20 54
    5 SSOR(L,K)=DB*DUMQ(L)                                                  6DA20 55
      NCOUNT=NCOUNT+1                                                       6DA20 56
    4 CONTINUE                                                              6DA20 57
    3 CONTINUE                                                              6DA20 58
      IF (NCOUNT.EQ.NSTRS) GO TO 10                                         6DA20 59
      WRITE(6,707)                                                          6DA20 60
      STOP                                                                  6DA20 61
   10 DO 11 J=1,NSTRS                                                       6DA20 62
      YY=YSN(J)                                                             6DA20 63
      IF (YY.GT.0.0) YY=-YY                                                 6DA20 64
      I=1                                                                   6DA20 65
   12 I=I+1                                                                 6DA20 66
      IF (YY    -Y(I)) 12,13,14                                             6DA20 67
   13 XWSOI(J)=XSNI(J)+XLEL(I)                                              6DA20 68
      YWSO(J)=YSN(J)                                                        6DA20 69
      ZWSO(J)=ZLEL(I)+ZSN(J)                                                6DA20 70
      GO TO 11                                                              6DA20 71
   14 FRAC=(YY    -Y(I-1))/(Y(I)-Y(I-1))                                    6DA20 72
      XWSOI(J)=XSNI(J)      +XLEL(I-1)+FRAC*(XLEL(I)-XLEL(I-1))            6DA20 73
      YWSO(J)=YSN(J)                                                        6DA20 74
      ZWSO(J)=ZSN(J)     +ZLEL(I-1)+FRAC*(ZLEL(I)-ZLEL(I-1))               6DA20 75
   11 CONTINUE                                                              6DA20 76
      RETURN                                                                6DA20 77
      END                                                                   6DA20 78
```

```
C     SUBROUTINE TO TRANSFORM FROM STORE TO INERTIAL SYSTEM                 6DA21  1
C                                                                           6DA21  2
      SUBROUTINE STTOIN (X,Y,Z,XI,ETA,ZETA,DC)                              6DA21  3
      DIMENSION DC(3,3)                                                     6DA21  4
      XI=X*DC(1,1)+Y*DC(1,2)+Z*DC(1,3)                                      6DA21  5
      ETA=X*DC(2,1)+Y*DC(2,2)+Z*DC(2,3)                                     6DA21  6
      ZETA=X*DC(3,1)+Y*DC(3,2)+Z*DC(3,3)                                    6DA21  7
      RETURN                                                                6DA21  8
      END                                                                   6DA21  9
```

```
C     SUBROUTINE TO OUTPUT THICKNESS SURFACE SLOPES                         6DA22  1
C                                                                           6DA22  2
      SUBROUTINE THOUT(MS,THETAL,BETA,NCWS,NPY,MPS,THETPL,NCPS)             6DA22  3
      DIMENSION THETAL(1),THETPL(1)                                         6DA22  4
  720 FORMAT(1H1,20X,56HINPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE I6DA22  5
     1HICKNESS/22X52HDISTRIBUTION. FOR EACH CHORDWISE ROW THE FIRST VALUE6DA22  6
     2E/27X,41HIS FOR THE PANEL NEAREST THE LEADING EDGE)                   6DA22  7
  721 FORMAT(/10X,19HWING THICKNESS DATA)                                   6DA22  8
  722 FORMAT(17X,3HROW,37X,6HSLOPES)                                        6DA22  9
  723 FORMAT(15X,I5,8F10.5,9(/20X,8F10.5))                                  6DA22 10
  724 FORMAT(/10X,20HPYLON THICKNESS DATA)                                  6DA22 11
      WRITE (6,720)                                                         6DA22 12
      WRITE (6,721)                                                         6DA22 13
      WRITE (6,722)                                                         6DA22 14
      DO 31 J=1,MS                                                          6DA22 15
   31 THETAL(J)=THETAL(J)/BETA                                              6DA22 16
      MN=0                                                                  6DA22 17
      DO 32 JNW=1,MS,NCWS                                                   6DA22 18
      MN=MN+NCWS                                                            6DA22 19
      I=MN/NCWS                                                             6DA22 20
   32 WRITE (6,723)(I,(THETAL(J),J=JNW,MN))                                 6DA22 21
      DO 33 J=1,MS                                                          6DA22 22
   33 THETAL(J)=THETAL(J)*BETA                                              6DA22 23
      IF (NPY.EQ.0) RETURN                                                  6DA22 24
      WRITE (6,724)                                                         6DA22 25
      WRITE (6,722)                                                         6DA22 26
      DO 34 J=1,MPS                                                         6DA22 27
   34 THETPL(J)=THETPL(J)/BETA                                              6DA22 28
      MN=0                                                                  6DA22 29
      DO 35 JNW=1,MPS,NCPS                                                  6DA22 30
      MN=MN+NCPS                                                            6DA22 31
      I=MN/NCPS                                                             6DA22 32
   35 WRITE (6,723)(I,(THETPL(J),J=JNW,MN))                                 6DA22 33
      DO 36 J=1,MPS                                                         6DA22 34
   36 THETPL(J)=THETPL(J)*BETA                                              6DA22 35
      RETURN                                                                6DA22 36
      END                                                                   6DA22 37
```

```
C     COMPUTE THICKNESS INDUCED VELOCITIES BY PYLON STRIPS UPON THE WING6DA23  1
C     AT THE VORTEX LATTICE CONTROL POINTS OR OTHER SPECIFIED FIELD      6DA23  2
C     POINTS GIVEN BY X, Y, Z FOR THE INCOMPRESSIBLE CONFIGURATION       6DA23  3
C                                                                        6DA23  4
      SUBROUTINE THPVEL(XC,YC,ZC,UP,VP,WP,JC)                           6DA23  5
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA23  6
     11),XLEL(31),ZLEL(31)                                              6DA23  7
      DIMENSION FACTOP(180),SWPPCS(180),XPRC(180),Z(5),SINSPS(180),     6DA23  8
     1COSSPS(180)                                                       6DA23  9
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA23 10
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA23 11
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA23 12
     1,SWPWTI,XLEL,ZLEL                                                 6DA23 13
      COMMON /PTHICK/ FACTOP,SWPPCS,XPRC,Z,SINSPS,COSSPS                6DA23 14
      U=0                                                               6DA23 15
      V=0                                                               6DA23 16
      W=0                                                               6DA23 17
      DO 7011 K=2,KMAX                                                  6DA23 18
      DO 7201 JCP=1,NCPS                                                6DA23 19
      JPS=(K-2)*NCPS+JCP                                                6DA23 20
      GD=FACTOP(JPS)                                                    6DA23 21
      IF (GD) 1,7201,1                                                  6DA23 22
    1 SINSWP=SINSPS(JPS)                                                6DA23 23
      COSSWP=COSSPS(JPS)                                                6DA23 24
      F=SQRT((XPRC(JPS)-XC-(Z(K-1)+ZLEL(IP))*SWPPCS(JPS))**2+(Y(IP)-YC) 6DA23 25
     1**2+(Z(K-1)+ZLEL(IP)-ZC)**2)                                      6DA23 26
      E=F+(Z(K-1)+ZLEL(IP))/COSSWP-(XPRC(JPS)-XC)*SINSWP-ZC*COSSWP      6DA23 27
      H=SQRT((XPRC(JPS)-XC-(Z(K)+ZLEL(IP))*SWPPCS(JPS))**2+(Y(IP)-YC)**26DA23 28
```


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Figure 10.- Continued.

```
     1+(Z(K)+ZLEL(IP)-ZC)**2)                                                  6DA23 29
       G=H+(Z(K)+ZLEL(IP))/COSSWP-(XPRC(JPS)-XC)*SINSWP-ZC*COSSWP              6DA23 30
       DZ=ZC-Z(K-1)-ZLEL(IP)                                                  6DA23 31
       RATIO=DZ/F                                                             6DA23 32
       IF (ABS(RATIO)-0.9999) 3,2,2                                           6DA23 33
     2 DZB=ZC-Z(K)-ZLEL(IP)                                                   6DA23 34
       WW= 6D*(1.0/DZB-1.0/DZ)                                                6DA23 35
       W=W+WW*COSSWP                                                          6DA23 36
       U=U-WW*SINSWP                                                          6DA23 37
       GO TO 4                                                                6DA23 38
     3 U=U+GD*((-XPRC(JPS)+XC+(Z(K-1)+ZLEL(IP))*SWPPCS(JPS)+F*SINSWP)/(E*6DA23 39
      1F)-(-XPRC(JPS)+XC+(Z(K)+ZLEL(IP))*SWPPCS(JPS)+H*SINSWP)/(G*H))         6DA23 40
       V=V+GD*((-Y(IP)+YC)/(E*F)-(-Y(IP)+YC)/(G*H))                           6DA23 41
       W=W+GD*((-(Z(K-1)+ZLEL(IP))+ZC-F*COSSWP)/(E*F)-(-(Z(K)+ZLEL(IP)))+ 6DA23 42
      1ZC-H*COSSWP)/(G*H))                                                    6DA23 43
     4 CONTINUE                                                               6DA23 44
  7201 CONTINUE                                                               6DA23 45
  7011 CONTINUE                                                               6DA23 46
C                                                                             6DA23 47
C      ADD UP INCOMPRESSIBLE VELOCITIES                                       6DA23 48
C                                                                            6DA23 49
       UP=UP+U                                                               6DA23 50
       VP=VP+V                                                               6DA23 51
       WP=WP+W                                                               6DA23 52
C                                                                            6DA23 53
       RETURN                                                                6DA23 54
       END                                                                   6DA23 55
```

```
C      COMPUTE THICKNESS INDUCED VELOCITIES BY THE WING STRIPS UPON THE      6DA24  1
C      PYLON AT THE VORTEX LATTICE CONTROL POINTS OR OTHER SPECIFIED         6DA24  2
C      FIELD POINTS GIVEN BY X, Y, Z FOR THE INCOMPRESSIBLE CONFIGURATION6DA24  3
C                                                                            6DA24  4
       SUBROUTINE THWVEL(XC,YC,ZC,UW,VW,WW,JC)                               6DA24  5
       DIMENSION SWPCS(400),SINSWS(400),COSSWS(400),XRC(400),Z1(400),        6DA24  6
      1FACTOR(400)                                                           6DA24  7
       DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA24  8
      11),XLEL(31),ZLEL(31)                                                  6DA24  9
       COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA24 10
      1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                          6DA24 11
       COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA24 12
      1,SWPWTI,XLEL,ZLEL                                                     6DA24 13
       COMMON /WTHICK/ SWPCS,SINSWS,COSSWS,XRC,Z1,FACTOR                     6DA24 14
       U=0                                                                   6DA24 15
       V=0                                                                   6DA24 16
       W=0                                                                   6DA24 17
       DO 7010 I=2,IMAX                                                      6DA24 18
       DO 7200 JCW=1,NCWS                                                    6DA24 19
       JS=(I-2)*NCWS+JCW                                                     6DA24 20
       F=1.0                                                                 6DA24 21
       DO 260 LSIDE=1,2                                                      6DA24 22
       Y(I)= F*Y(I)                                                          6DA24 23
       Y(I-1)= F*Y(I-1)                                                      6DA24 24
       SWPCS(JS)=  F *SWPCS(JS)                                              6DA24 25
       SINSWP=SINSWS(JS)                                                     6DA24 26
       COSSWP=COSSWS(JS)*F                                                   6DA24 27
       B=SQRT((XRC(JS)-XC+Y(I-1)*SWPCS(JS))**2+(YC-Y(I-1))**2+(Z1(JS)-ZC)6DA24 28
      1**2)                                                                  6DA24 29
       A=B-(Y(I-1)/COSSWP)+(XC-XRC(JS))*SINSWP+YC*COSSWP                     6DA24 30
       D=SQRT((XRC(JS)-XC+Y(I)*SWPCS(JS))**2+(YC-Y(I))**2+(Z1(JS)-ZC)**2)6DA24 31
       C=D-(Y(I)/COSSWP)+(XC-XRC(JS))*SINSWP+YC*COSSWP                       6DA24 32
       U=U+FACTOR(JS)*((-XRC(JS)+XC-Y(I-1)*SWPCS(JS)+A*SINSWP)/(A*B)-(-XR6DA24 33
      1C(JS)+XC-Y(I)*SWPCS(JS)+D*SINSWP)/(C*D))                              6DA24 34
       V=V+FACTOR(JS)*((YC-Y(I-1)+B*COSSWP)/(A*B)-(YC-Y(1)+D*COSSWP)/(C*D6DA24 35
      1))                                                                    6DA24 36
       W=W+FACTOR(JS)*((ZC    -Z1(JS))/(A*b)-(ZC    -Z1(JS))/(C*D))          6DA24 37
       F=-F                                                                  6DA24 38
  260 CONTINUE                                                               6DA24 39
       Y(I)=-Y(I)                                                            6DA24 40
       Y(I-1)=-Y(I-1)                                                        6DA24 41
       SWPCS(JS)=-SWPCS(JS)                                                  6DA24 42
  7200 CONTINUE                                                              6DA24 43
  7010 CONTINUE                                                              6DA24 44
C                                                                            6DA24 45
C      ADD UP INCOMPRESSIBLE VELOCITIES                                      6DA24 46
C                                                                            6DA24 47
       UW=UW+U                                                               6DA24 48
       VW=VW+V                                                               6DA24 49
       WW=WW+W                                                               6DA24 50
C                                                                            6DA24 51
       RETURN                                                                6DA24 52
       END                                                                   6DA24 53
```

```
C      SUBROUTINE TO CALCULATE PERTURBATION VELOCITIES                       6DA25  1
C                                                                           6DA25  2
       SUBROUTINE VELFLD (XB,YB,ZB,UTU,VTV,WTW)                              6DA25  3
       DIMENSION VAR(12),DC(3,3),UT(81),VT(81),WT(81),FXL(100),FSOR(100),6DA25  4
      1RXL(100),RSOR(100),XBSOI(10),CSIBIR(10),ZBSO(10),SSIBIR(10),       6DA25  5
      2YBSO(10),SXL(100,10),SSOR(100,10),NSSOR(10),SRMAX(10),ERAD(81),    6DA25  6
      3CNX(40),CYX(40),EDRDX(81),SIIR(10),CSIIR(10),SSIIR(10),XWSOI(10), 6DA25  7
      4YWSO(10),ZWSO(10)                                                    6DA25  8
       COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA25  9
      1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                         6DA25 10
       COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                               6DA25 11
       COMMON /LOCA/ WIIR,CWIIR,SWIIR,XBWOI,ZBWO,XWROI,YWRO,ZWRO,RIIR,     6DA25 12
      1CRIIR,SRIIR,SIIR,CSIIR,SSIIR,XWSOI,YWSO,ZWSO                         6DA25 13
       COMMON /SOURCE/ FXL,FSOR,NFSOR,FRMAX,RXL,RSOR,NRSOR,RMAX,SXL,SSOR6DA25 14
      1,NSSOR,SRMAX                                                         6DA25 15
       COMMON/IFORCE/NHSEG,NEJSTR,NDAMP,NGAM,NEMP,NROLL,NHSEGO              6DA25 16
       COMMON/CFORCE/VAR,DC,UT,VT,WT,DXI,DX,XBRO1,ZBRO,YBRO,XBSOI,CSIBIR,6DA25 17
      1ZBSO,SSIBIR,YBSO,VINF,ALFACR,VSTOKE,XMOM,ESTRMX,CDC,CNBY,CYBY,     6DA25 18
      2CLMBY,CLNBY,ERAD,DELX,CNX,CYX,CNSB,CYSB,CLMSB,CLNSB,FDRDX,CNCF,    6DA25 19
      3CYCF,CLMCF,CLNCF                                                     6DA25 20
       COMMON /FORVEL/ CRIFI,SRIFI,BETASQ                                   6DA25 21
C                                                                           6DA25 22
C      CALCULATE INCOMPRESSIBLE FUSELAGE INDUCED VELOCITIES                 6DA25 23
C                                                                           6DA25 24
       NCON=1                                                               6DA25 25
       IF(NFU.EQ.0) GO TO 110                                               6DA25 26
       CALL VELOC (XB,YB,ZB,FXL,FSOR,NFSOR,UF,VF,WF,FRMAX)                  6DA25 27
       UTU=UTU+UF                                                           6DA25 28
       VTV=VTV+VF                                                           6DA25 29
       WTW=WTW+WF                                                           6DA25 30
       IF (ZBWO.GE.FRMAX/2.0) GO TO 110                                     6DA25 31
       IF (ABS(YB).GT.FRMAX) GO TO 110                                      6DA25 32
       SALF=SIN(ALFACR*BETA)                                                6DA25 33
       WF=SALF*(FRMAX/ZB)**2                                                6DA25 34
       WTW=WTW+WF                                                           6DA25 35
C                                                                           6DA25 36
C      LOCATE POINT IN WING COORDINATE SYSTEM                               6DA25 37
C                                                                           6DA25 38
       IF (NPY.EQ.0) GO TO 25                                               6DA25 39
       IF (IP.NE.1) GO TO 25                                                6DA25 40
       NCON=2                                                               6DA25 41
  110 XW=(XB-XBWOI)*CWIIR-(ZB-ZBWO)*SWIIR                                   6DA25 42
       YW=YB                                                                6DA25 43
       ZW=(XB-XBWOI)*SWIIR+(ZB-ZBWO)*CWIIR                                  6DA25 44
C                                                                           6DA25 45
C      CALCULATE VELOCITIES INDUCED BY WING AND PYLON, BOTH VORTEX          6DA25 46
C      LATTICE AND THICKNESS                                                6DA25 47
C                                                                           6DA25 48
       CALL VLIVEL (XW,YW,ZW,UF,VF,WF,NCON)                                 6DA25 49
       UTU  =UTU  +UF*CWIIR+WF*SWIIR                                        6DA25 50
       VTV  =VTV  +VF                                                       6DA25 51
       WTW  =WTW  +WF*CWIIR-UF*SWIIR                                        6DA25 52
   25 CONTINUE                                                              6DA25 53
```


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Figure 10.- Continued.

```
C                                                                       6DA25  54
C     LOCATE POINT IN RACK COORDINATE SYSTEM                            6DA25  55
C                                                                       6DA25  56
      IF (NRACK.EQ.0) GO TO 30                                          6DA25  57
      XR=(XB-XBRO1)*CRIFI-(ZB-ZBRO)*SRIFI                               6DA25  58
      YR=YB-YBRO                                                        6DA25  59
      ZR=(XB-XBRO1)*SRIFI+(ZB-ZBRO)*CRIFI                               6DA25  60
C                                                                       6DA25  61
C     CALCULATE RACK INDUCED VELOCITIES                                 6DA25  62
C                                                                       6DA25  63
      CALL VELOC (XR,YR,ZR,RXL,RSOR,NRSOR,UF,VF,WF,RRMAX)               6DA25  64
      UTU  =UTU  +UF*CRIFI+WF*SRIFI                                     6DA25  65
      VTV  =VTV  +VF                                                    6DA25  66
      WTW  =WTW  +WF*CRIFI-UF*SRIFI                                     6DA25  67
   30 CONTINUE                                                          6DA25  68
C                                                                       6DA25  69
C     CALCULATE VELOCITIES INDUCED BY OTHER STORES                      6DA25  70
C                                                                       6DA25  71
      IF (NSTRS.LE.1) GO TO 50                                          6DA25  72
      DO 41 J=1,NSTRS                                                   6DA25  73
      IF (J.EQ.NEJSTR) GO TO 41                                         6DA25  74
C                                                                       6DA25  75
C     LOCATE POINT IN STORE COORDINATE SYSTEM                           6DA25  76
C                                                                       6DA25  77
      XS=(XB-XBSOI(J))*CSIBIR(J)-(ZB-ZBSO(J))*SSIBIR(J)                 6DA25  78
      YS=YB-YBSO(J)                                                     6DA25  79
      ZS=(XB-XBSOI(J))*SSIBIR(J)+(ZB-ZBSO(J))*CSIBIR(J)                 6DA25  80
C                                                                       6DA25  81
C     CALCULATE INDUCED VELOCITIES                                      6DA25  82
C                                                                       6DA25  83
      CALL VELOC(XS,YS,ZS,SXL(1,J),SSOR(1,J),NSSOR(J),UF,VF,WF,SRMAX(J) 6DA25  84
     1)                                                                 6DA25  85
      UTU  =UTU  +UF*CSIBIR(J)+WF*SSIBIR(J)                             6DA25  86
      VTV  =VTV  +VF                                                    6DA25  87
      WTW  =WTW  +WF*CSIBIR(J)-UF*SSIBIR(J)                             6DA25  88
   41 CONTINUE                                                          6DA25  89
   50 CONTINUE                                                          6DA25  90
C                                                                       6DA25  91
C     TRANSFORM VELOCITIES TO COMPRESSIBLE SPACE AND RESOLVE INTO STORE 6DA25  92
C     COORDINATE SYSTEM                                                 6DA25  93
C                                                                       6DA25  94
      UTT=UTU  /BETASQ                                                  6DA25  95
      VTT=VTV  /BETA                                                    6DA25  96
      WTT=WTW  /BETA                                                    6DA25  97
      CALL INTOST (UTT,VTT,WTT,UTU,VTV,WTW,DC)                          6DA25  98
      RETURN                                                            6DA25  99
      END                                                               6DA25100
```

```
C     SUBROUTINE TO CALCULATE PERTURBATION VELOCITIES AT A FIELD POINT  6DA26   1
C       OF AN AXISYMMETRIC BODY REPRESENTED BY POINT SOURCES AND SINKS  6DA26   2
C                                                                       6DA26   3
      SUBROUTINE VELOC (X,Y,Z,XS,SS,NS,U,V,W,RMAX)                      6DA26   4
      DIMENSION XS(1),SS(1)                                             6DA26   5
      R=SQRT(Y*Y+Z*Z)                                                   6DA26   6
      RS=R*R                                                            6DA26   7
      U=0.0                                                             6DA26   8
      IF (NS.EQ.0) GO TO 7                                              6DA26   9
      VR=0.0                                                            6DA26  10
      IF (R.GE.RMAX) 4,4,5                                              6DA26  11
    4 PSI=0.5*RS                                                        6DA26  12
      DO 6 N=1,NS                                                       6DA26  13
      DX=X-XS(N)                                                        6DA26  14
      D=SQRT(DX*DX+RS)                                                  6DA26  15
    6 PSI=PSI-SS(N)*(1.0-DX/D)                                          6DA26  16
      IF (PSI) 7,7,5                                                    6DA26  17
    7 V=0.0                                                             6DA26  18
      W=0.0                                                             6DA26  19
      RETURN                                                            6DA26  20
    5 DO 1 N=1,NS                                                       6DA26  21
      DX=X-XS(N)                                                        6DA26  22
      D=(DX*DX+RS)**1.5                                                 6DA26  23
      U=U+SS(N)*DX/D                                                    6DA26  24
    1 VR=VR+SS(N)*R/D                                                   6DA26  25
      IF (Y) 3,2,3                                                      6DA26  26
    2 W=VR                                                              6DA26  27
      V=0.0                                                             6DA26  28
      IF (Z.LT.0.0) W=-W                                                6DA26  29
      RETURN                                                            6DA26  30
    3 PHI=ATAN(ABS(Z/Y))                                                6DA26  31
      V=VR*COS(PHI)                                                     6DA26  32
      W=VR*SIN(PHI)                                                     6DA26  33
      IF (Z.LT.0.0) W=-W                                                6DA26  34
      IF (Y.LT.0.0) V=-V                                                6DA26  35
      RETURN                                                            6DA26  36
      END                                                               6DA26  37
```

```
C     SUBROUTINE TO COMPUTE VORTEX LATTICE COEFFICIENT MATRIX           6DA27   1
C                                                                       6DA27   2
      SUBROUTINE VLCOEF (FVN,PCX,PVX,PVY,PVZ,SWPVV,PHI,SW,COSPHI,SINPHI,6DA27   3
     1PVPX,PVPY,PVPZ,SWPVP,SP,PCPX)                                     6DA27   4
      DIMENSION FVN(100,101),PCX(1),PVX(1),PVY(1),PVZ(1),SWPVV(1),PHI(1)6DA27   5
     1,SW(1),COSPHI(1),SINPHI(1),PVPX(1),PVPY(1),PVPZ(1),SWPVP(1),SP(1),6DA27   6
     2PCPX(1)                                                           6DA27   7
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA27   8
     11),XLEL(31),ZLEL(31)                                              6DA27   9
      DIMENSION YWW(2),FUW(2),FVW(2),FWW(2),YWP(2),FUP(2),FVP(2),FWP(2),6DA27  10
     1YPW(2),YPP(2)                                                     6DA27  11
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA27  12
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA27  13
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA27  14
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLF,PSIWTE,PHID,SWPWLI6DA27  15
     1,SWPWTI,XLEL,ZLEL                                                 6DA27  16
      DO 1 J=1,100                                                      6DA27  17
      DO 1 K=1,100                                                      6DA27  18
    1 FVN(J,K)=0.0                                                      6DA27  19
C                                                                       6DA27  20
C     CONSTRUCT INFLUENCE COEFFICIENT MATRIX FOR THE INCOMPRESSIBLE WING6DA27  21
C     PYLON                                                             6DA27  22
C                                                                       6DA27  23
C     CONTROL POINTS ON WING, VORTICES ON WING                          6DA27  24
C                                                                       6DA27  25
      DO 212 JC=1,M                                                     6DA27  26
      DO 212 JV=1,M                                                     6DA27  27
      XWW=PCX(JC)-PVX(JV)                                               6DA27  28
      YWW(1)=PVY(JC)-PVY(JV)                                            6DA27  29
      YWW(2)=PVY(JC)+PVY(JV)                                            6DA27  30
      ZWW=PVZ(JC)-PVZ(JV)                                               6DA27  31
      DO 261 I=1,2                                                      6DA27  32
      CALL INFWW (SWPVV(JV),PHI(JV),XWW,YWW(I),ZWW,SW(JV),FUW(I),FVW(I),6DA27  33
     1FWW(I))                                                           6DA27  34
      SWPVV (JV)=-SWPVV (JV)                                            6DA27  35
      PHI(JV)=-PHI(JV)                                                  6DA27  36
  261 CONTINUE                                                          6DA27  37
      FVN(JC,JV)=(FWW(1)+FWW(2))*COSPHI(JC)-(FVW(1)+FVW(2))*SINPHI(JC)  6DA27  38
  212 CONTINUE                                                          6DA27  39
C                                                                       6DA27  40
C     CONTROL POINTS ON WING, VORTICES ON PYLON                         6DA27  41
C                                                                       6DA27  42
      IF (NPY.EQ.0.OR.IP.EQ.1) GO TO 1103                               6DA27  43
      DO 312 JC=1,M                                                     6DA27  44
      DO 312 JV=MP1,MMP                                                 6DA27  45
      JVP=JV-M                                                          6DA27  46
      XWP=PCX(JC)-PVPX(JVP)                                             6DA27  47
      YWP(1)=PVY(JC)-PVPY(JVP)                                          6DA27  48
      YWP(2)=PVY(JC)+PVPY(JVP)                                          6DA27  49
```


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Figure 10.- Continued.

```
      ZWP=PVZ(JC)-PVPZ(JVP)                                              6DA27 50
      DO 262 I=1,2                                                       6DA27 51
      CALL INFWW(SWPVP(JVP),PHIP,XWP,YWP(1),ZWP,SP(JVP),FUP(I),FVP(I),   6DA27 52
     1FWP(I))                                                            6DA27 53
      PHIP=-PHIP                                                         6DA27 54
      SWPVP(JVP)=-SWPVP(JVP)                                             6DA27 55
  262 CONTINUE                                                           6DA27 56
      FVN(JC,JV)=(FWP(1)+FWP(2))*COSPHI(JC)-(FVP(1)+FVP(2))*SINPHI(JC)   6DA27 57
  312 CONTINUE                                                           6DA27 58
C                                                                        6DA27 59
C     CONTROL POINTS ON PYLON, VORTICES ON WING                          6DA27 60
C                                                                        6DA27 61
      DO 412 JC=MP1,MMP                                                  6DA27 62
      JCP=JC-M                                                           6DA27 63
      DO 412 JV=1,M                                                      6DA27 64
      XPW=PCPX(JCP)-PVX(JV)                                              6DA27 65
      YPW(1)=PVPY(JCP)-PVY(JV)                                           6DA27 66
      YPW(2)=PVPY(JCP)+PVY(JV)                                           6DA27 67
      ZPW=PVPZ(JCP)-PVZ(JV)                                              6DA27 68
      DO 263 I=1,2                                                       6DA27 69
      CALL INFWW (SWPVV(JV),PHI(JV),XPW,YPW(I),ZPW,SW(JV),FUW(I),FVW(I),6DA27 70
     1FWW(I))                                                            6DA27 71
      SWPVV (JV)=-SWPVV (JV)                                             6DA27 72
      PHI(JV)=-PHI(JV)                                                   6DA27 73
  263 CONTINUE                                                           6DA27 74
      FVN(JC,JV)= -(FVW(1)+FVW(2))                                       6DA27 75
  412 CONTINUE                                                           6DA27 76
C                                                                        6DA27 77
C     CONTROL POINTS ON PYLON, VORTICES ON PYLON                         6DA27 78
C                                                                        6DA27 79
      DO 512 JC=MP1,MMP                                                  6DA27 80
      JCP=JC-M                                                           6DA27 81
      DO 512 JV=MP1,MMP                                                  6DA27 82
      JVP=JV-M                                                           6DA27 83
      XPP=PCPX(JCP)-PVPX(JVP)                                            6DA27 84
      YPP(1)=0.0                                                         6DA27 85
      YPP(2)=-Y(IP)*2.0                                                  6DA27 86
      ZPP=PVPZ(JCP)-PVPZ(JVP)                                            6DA27 87
      DO 264 I=1,2                                                       6DA27 88
      CALL INFWW(SWPVP(JVP),PHIP,XPP,YPP(1),ZPP,SP(JVP),FUP(I),FVP(I),   6DA27 89
     1FWP(I))                                                            6DA27 90
      PHIP=-PHIP                                                         6DA27 91
      SWPVP(JVP)=-SWPVP(JVP)                                             6DA27 92
  264 CONTINUE                                                           6DA27 93
      FVN(JC,JV)= -(FVP(1)+FVP(2))                                       6DA27 94
  512 CONTINUE                                                           6DA27 95
 1103 CONTINUE                                                           6DA27 96
      RETURN                                                             6DA27 97
      END                                                                6DA27 98
```

```
C     WING-PYLON INDUCED PERTURBATION VELOCITIES AT SPECIFIED FIELD      6DA28  1
C     POINTS                                                             6DA28  2
C                                                                        6DA28  3
      SUBROUTINE VLIVEL(PMX,PMY,PMZ,UI,VI,WI,NCOM)                       6DA29  4
C                                                                        6DA28  5
      DIMENSION YWM(2),YPM(2),FUW(2),FVW(2),FWW(2),FUP(2),FVP(2),FWP(2)  6DA29  6
      DIMENSION CIR(150),PVX(120),PVY(120),PVZ(120),                     6DA28  7
     1          PVPX(30),PVPY(30),PVPZ(30)                               6DA28  8
      DIMENSION SWPVV(120),SWPVP(30),SW(120),SP(30),PHI(120)             6DA28  9
      COMMON /CVLIVL/ PVX,PVY,PVZ,SWPVV,PHI,SW,CIR,PVPX,PVPY,PVPZ,SWPVP,6DA28 10
     1SP                                                                 6DA28 11
      COMMON /INDEX/ NCW,MSW,M,MMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS,  6DA28 12
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                       6DA28 13
C                                                                        6DA28 14
C     COMPUTE INDUCED VELOCITIES AT POINTS (PMX,PMY,PMZ) DUE TO WING     6DA28 15
C     VORTICES                                                           6DA28 16
C                                                                        6DA28 17
      UI=0.0                                                             6DA28 18
      VI=0.0                                                             6DA28 19
      WI=0.0                                                             6DA28 20
      IF (NCON.EQ.2) GO TO 10                                            6DA28 21
      DO 5000 JV=1,M                                                     6DA28 22
      XWM=PMX    -PVX(JV)                                                6DA28 23
      YWM(1)=PMY    -PVY(JV)                                             6DA28 24
      YWM(2)=PMY    +PVY(JV)                                             6DA28 25
      ZWM=PMZ    -PVZ(JV)                                                6DA28 26
      DO 1261 I=1,2                                                      6DA28 27
      CALL INFWW (SWPVV(JV),PHI(JV),XWM,YWM(I),ZWM,SW(JV),FUW(I),FVW(I),6DA28 28
     1FWW(I))                                                            6DA28 29
      SWPVV(JV)=-SWPVV(JV)                                               6DA28 30
      PHI(JV)=-PHI(JV)                                                   6DA28 31
 1261 CONTINUE                                                           6DA28 32
      UI    =UI    +((FUW(1)+FUW(2))*CIR(JV))/12.566371                  6DA28 33
      VI    =VI    +((FVW(1)+FVW(2))*CIR(JV))/12.566371                  6DA28 34
      WI    =WI    +((FWW(1)+FWW(2))*CIR(JV))/12.566371                  6DA28 35
 5000 CONTINUE                                                           6DA28 36
C                                                                        6DA28 37
C     COMPUTE INDUCED VELOCITIES AT POINTS (PMX,PMY,PMZ) DUE TO PYLON    6DA28 38
C     VORTICES                                                           6DA28 39
C                                                                        6DA28 40
      IF (NCP.EQ.0) GO TO 5036                                           6DA28 41
      PHIP=-1.5707963                                                    6DA28 42
      DO 5010 JV=MP1,MMP                                                 6DA28 43
      JVP=JV-M                                                           6DA28 44
      XPM=PMX    -PVPX(JVP)                                              6DA28 45
      YPM(1)=PMY    -PVPY(JVP)                                           6DA28 46
      YPM(2)=PMY    +PVPY(JVP)                                           6DA28 47
      ZPM=PMZ    -PVPZ(JVP)                                              6DA28 48
      DO 1271 I=1,2                                                      6DA28 49
      CALL INFWW(SWPVP(JVP),PHIP,XPM,YPM(I),ZPM,SP(JVP),FUP(I),FVP(I),   6DA28 50
     1FWP(I))                                                            6DA28 51
      PHIP=-PHIP                                                         6DA28 52
      SWPVP(JVP)=-SWPVP(JVP)                                             6DA28 53
 1271 CONTINUE                                                           6DA28 54
      UI    =UI    +((FUP(1)+FUP(2))*CIR(JV))/12.566371                  6DA28 55
      VI    =VI    +((FVP(1)+FVP(2))*CIR(JV))/12.566371                  6DA28 56
      WI    =WI    +((FWP(1)+FWP(2))*CIR(JV))/12.566371                  6DA28 57
 5010 CONTINUE                                                           6DA28 58
 5036 CONTINUE                                                           6DA28 59
C                                                                        6DA28 60
C     WING THICKNESS INDUCED VELOCITIES AT POINTS PMX, PMY, PMZ          6DA28 61
C                                                                        6DA28 62
      CALL THWVEL(PMX,PMY,PMZ,U1,VI,W1,1)                                6DA28 63
C                                                                        6DA28 64
C     PYLON THICKNESS INDUCED VELOCITIES AT POINTS, PMX, PMY, PMZ        6DA28 65
C                                                                        6DA28 66
      IF(NCP.EQ.0) GO TO 5015                                            6DA28 67
   10 CALL THPVEL(PMX,PMY,PMZ,U1,VI,W1,1)                                6DA28 68
 5015 CONTINUE                                                           6DA28 69
      RETURN                                                             6DA28 70
      END                                                                6DA28 71
```


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Figure 10.- Continued.

```
C     SUBROUTINE TO OUTPUT VORTEX LATTICE CONTROL POINT DATA                6DA29  1
C                                                                           6DA29  2
      SUBROUTINE VLOUT(M,NCW,PCX,BETA,PVY,PVZ,ALPHAL,NPY,MP1,MMP,NCP,       6DA29  3
                                                                            6DA29  4
     1PCPX,PVPY,PVPZ)                                                       6DA29  5
      DIMENSION PCX(1),PVY(1),PVZ(1),ALPHAL(1),PCPX(1),PVPY(1),PVPZ(1)      6DA29  6
  714 FORMAT(1H1,21X,44HVORTEX LATTICE CONTROL POINT COORDINATES AND/25X    6DA29  7
     1,35HINPUT TWIST AND CAMBER DISTRIBUTION/34X,15HAT THESE POINTS/30X    6DA29  8
     2,24H(WING COORDINATE SYSTEM))                                         6DA29  9
  715 FORMAT(/10X,19HWING CONTROL POINTS)                                   6DA29 10
  716 FORMAT(17X,10HROW VORTEX,5X,5HX, FT,6X,5HY, FT,6X,5HZ, FT,6X,5HSLO    6DA29 11
     1PE)                                                                   6DA29 12
  717 FORMAT(15X,2I5,3X,4F11.5)                                             6DA29 13
  718 FORMAT(/10X,20HPYLON CONTROL POINTS)                                  6DA29 14
  719 FORMAT(17X,10HROW VORTEX,5X,5HX, FT,6X,5HY, FT,6X,5HZ, FT)            6DA29 15
C                                                                           6DA29 16
C     OUTPUT VORTEX LATTICE CONTROL POINT COORDINATES AND INPUT CAMBER      6DA29 17
C          DISTRIBUTION                                                     6DA29 18
C                                                                           6DA29 19
      WRITE (6,714)                                                         6DA29 20
      WRITE (6,715)                                                         6DA29 21
      WRITE (6,716)                                                         6DA29 22
      DO 21 J=1,M                                                           6DA29 23
      NROW=(J-1)/NCW+1                                                      6DA29 24
      NVOR=J-NCW*(NROW-1)                                                   6DA29 25
      PCXC=PCX(J)*BETA                                                      6DA29 26
   21 WRITE (6,717) NROW,NVOR,PCXC,PVY(J),PVZ(J),ALPHAL(J)                  6DA29 27
      IF (NPY.EQ.0) RETURN                                                  6DA29 28
      WRITE (6,718)                                                         6DA29 29
      WRITE (6,719)                                                         6DA29 30
      DO 22 J=MP1,MMP                                                       6DA29 31
      NROW=(J-M-1)/NCP+1                                                    6DA29 32
      NVOR=J-M-NCP*(NROW-1)                                                 6DA29 33
      JP=J-M                                                                6DA29 34
      PCPXC=PCPX(JP)*BETA                                                   6DA29 35
   22 WRITE (6,717) NROW,NVOR,PCPXC,PVPY(JP),PVPZ(JP)                       6DA29 36
      RETURN                                                                6DA29 37
      END
```

```
C     SUBROUTINE TO COMPUTE RIGHT HAND SIDE OF EQUATIONS TO BE SOLVED       6DA30  1
C          FOR VORTEX STRENGTHS                                             6DA30  2
C                                                                           6DA30  3
      SUBROUTINE VLRHS (PCX,PVY,PVZ,PCPX,PVPY,PVPZ,ALFAIR,ALPHLI,COSPHI,    6DA30  4
     1SINPHI,CIR,UEI,VEI,WEI)                                               6DA30  5
      DIMENSION PCX(1),PVY(1),PVZ(1),PCPX(1),PVPY(1),PVPZ(1),ALPHLI(1),     6DA30  6
     1COSPHI(1),SINPHI(1),CIR(1),UEI(1),VEI(1),WEI(1)                       6DA30  7
      DIMENSION FXL(100),FSOR(100),RXL(100),RSOR(100),SIIR(10),CSIIR(10)    6DA30  8
     1,SSIIR(10),XWSOI(10),YWSO(10),ZWSO(10),SXL(100,10),SSOR(100,10),     6DA30  9
     2NSSOR(10),SRMAX(10)                                                   6DA30 10
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS,     6DA30 11
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                          6DA30 12
      COMMON /LOCA/ WIIR,CWIIR,SWIIR,XBWOI,ZBWO,XWROI,YWRO,ZWRO,RIIR,       6DA30 13
     1CRIIR,SRIIR,SIIR,CSIIR,SSIIR,XWSOI,YWSO,ZWSO                          6DA30 14
      COMMON /SOURCE/ FXL,FSOR,NFSOR,FRMAX,RXL,RSOR,NRSOR,RRMAX,SXL,SSOR    6DA30 15
     1,NSSOR,SRMAX                                                          6DA30 16
      DO 1 J=1,MMP                                                          6DA30 17
      UEI(J)=0.0                                                            6DA30 18
      VEI(J)=0.0                                                            6DA30 19
    1 WEI(J)=0.0                                                            6DA30 20
C                                                                           6DA30 21
C     CALCULATE FUSELAGE INDUCED VELOCITIES                                 6DA30 22
C                                                                           6DA30 23
      IF (NFU.EQ.0) GO TO 20                                                6DA30 24
      IF (ZBWO) 2,3,2                                                       6DA30 25
    3 IF (WIIR) 2,10,2                                                      6DA30 26
    2 DO 4 NV=1,M                                                           6DA30 27
      XBW=XBWOI*PCX(NV)*CWIIR+PVZ(NV)*SWIIR                                 6DA30 28
      YBW=PVY(NV)                                                           6DA30 29
      ZBW=ZBWO+PVZ(NV)*CWIIR-PCX(NV)*SWIIR                                  6DA30 30
      CALL VELOC (XBW,YBW,ZBW,FXL,FSOR,NFSOR,UI,VI,WI,FRMAX)                6DA30 31
      UEI(NV)=UEI(NV)+UI*CWIIR-WI*SWIIR                                     6DA30 32
      VEI(NV)=VEI(NV)+VI                                                    6DA30 33
    4 WEI(NV)=WEI(NV)+WI*CWIIR+UI*SWIIR                                     6DA30 34
   10 IF (NPY.EQ.0.OR.IP.EQ.1) GO TO 20                                     6DA30 35
      DO 11 NV=MP1,MMP                                                      6DA30 36
      NC=NV-M                                                               6DA30 37
      XBP=XBWOI+PCPX(NC)*CWIIR+PVPZ(NC)*SWIIR                               6DA30 38
      YBP=PVPY(NC)                                                          6DA30 39
      ZBP=ZBWO+PVPZ(NC)*CWIIR-PCPX(NC)*SWIIR                                6DA30 40
      CALL VELOC (XBP,YBP,ZBP,FXL,FSOR,NFSOR,UI,VI,WI,FRMAX)                6DA30 41
   11 VEI(NV)=VEI(NV)+VI                                                    6DA30 42
C                                                                           6DA30 43
C     CALCULATE RACK INDUCED VELOCITIES                                     6DA30 44
C                                                                           6DA30 45
   20 IF (NRACK.EQ.0) GO TO 30                                              6DA30 46
      DO 21 NV=1,M                                                          6DA30 47
      XRW=-(XWROI-PCX(NV))*CRIIR+(ZWRO-PVZ(NV))*SRIIR                       6DA30 48
      YRW=-(YWRO-PVY(NV))                                                   6DA30 49
      ZRW=-(ZWRO-PVZ(NV))*CRIIR-(XWROI-PCX(NV))*SRIIR                       6DA30 50
      CALL VELOC (XRW,YRW,ZRW,RXL,RSOR,NRSOR,UI,VI,WI,RRMAX)                6DA30 51
      UEI(NV)=UEI(NV)+UI*CRIIR-WI*SRIIR                                     6DA30 52
      VEI(NV)=VEI(NV)+VI                                                    6DA30 53
   21 WEI(NV)=WEI(NV)+WI*CRIIR+UI*SRIIR                                     6DA30 54
C                                                                           6DA30 55
C     CALCULATE STORE INDUCED VELOCITIES                                    6DA30 56
C                                                                           6DA30 57
   30 IF (NSTRS.EQ.0) GO TO 39                                              6DA30 58
      DO 31 N=1,NSTRS                                                       6DA30 59
      CI=CSIIR(N)                                                           6DA30 60
      SI=SSIIR(N)                                                           6DA30 61
      XSO=XWSOI(N)                                                          6DA30 62
      YSO=YWSO(N)                                                           6DA30 63
      ZSO=ZWSO(N)                                                           6DA30 64
      DO 32 NV=1,M                                                          6DA30 65
      XSW=-(XSO-PCX(NV))*CI+(ZSO-PVZ(NV))*SI                                6DA30 66
      YSW=-(YSO-PVY(NV))                                                    6DA30 67
      ZSW=-(ZSO-PVZ(NV))*CI-(XSO-PCX(NV))*SI                                6DA30 68
      CALL VELOC (XSW,YSW,ZSW,SXL(1,N),SSOR(1,N),NSSOR(N),UI,VI,WI,         6DA30 69
     1SRMAX(N))                                                             6DA30 70
      UEI(NV)=UEI(NV)+UI*CI-WI*SI                                           6DA30 71
      VEI(NV)=VEI(NV)+VI                                                    6DA30 72
   32 WEI(NV)=WEI(NV)+WI*CI+UI*SI                                           6DA30 73
      IF (NPY.EQ.0.OR.IP.EQ.1) GO TO 31                                     6DA30 74
      DO 33 NV=MP1,MMP                                                      6DA30 75
      NC=NV-M                                                               6DA30 76
      XSP=-(XSO-PCPX(NC))*CI+(ZSO-PVPZ(NC))*SI                              6DA30 77
      YSP=-(YSO-PVPY(NC))                                                   6DA30 78
      ZSP=-(ZSO-PVPZ(NC))*CI-(XSO-PCPX(NC))*SI                              6DA30 79
      CALL VELOC (XSP,YSP,ZSP,SXL(1,N),SSOR(1,N),NSSOR(N),UI,VI,WI,         6DA30 80
     1SRMAX(N))                                                             6DA30 81
   33 VEI(NV)=VEI(NV)+VI                                                    6DA30 82
   31 CONTINUE                                                              6DA30 83
   39 CONTINUE                                                              6DA30 84
C                                                                           6DA30 85
C     CALCULATE PYLON THICKNESS INDUCED VELOCITIES ON WING                  6DA30 86
C                                                                           6DA30 87
      IF (NPY.EQ.0) GO TO 50                                                6DA30 88
      DO 40 NV=1,M                                                          6DA30 89
   40 CALL THPVEL (PCX(NV),PVY(NV),PVZ(NV),UF1(NV),VF1(NV),WF1(NV),NV)      6DA30 90
C                                                                           6DA30 91
C     COMPUTE WING THICKNESS INDUCED VELOCITIES ON PYLON                    6DA30 92
C                                                                           6DA30 93
      IF (IP.EQ.1) GO TO 50                                                 6DA30 94
      DO 41 NV=MP1,MMP                                                      6DA30 95
      NC=NV-M                                                               6DA30 96
      CALL THWVEL (PCPX(NC),PVPY(NC),PVPZ(NC),UEI(NV),VEI(NV),WEI(NV),NV    6DA30 97
     1)                                                                     6DA30 98
   41 CONTINUE                                                              6DA30 99
C                                                                           6DA30100
C     CALCULATE RIGHT HAND SIDE                                             6DA30101
C                                                                           6DA30102
```


Figure 10.- Continued.

```
   50 DO 51 NV=1,M                                                      6DA30103
   51 CIR(NV)=12.566371*((ALFAIR+ALPHLI(NV))*COSPHI(NV)+VEI(NV)*SINPHI(N6DA30104
     1V)-(UEI(NV)*ALPHLI(NV)+WEI(NV))*COSPHI(NV))                       6DA30105
      IF (NPY.EQ.0.OR.IP.EQ.1) RETURN                                   6DA30106
      DO 52 NV=MP1,MMP                                                  6DA30107
   52 CIR(NV)=12.566371*VEI(NV)                                         6DA30108
      RETURN                                                            6DA30109
      END                                                               6DA30110
```

```
C     SUBROUTINE TO OUTPUT INTERFERENCE VELOCITIES AND VORTEX STRENGTHS 6DA31  1
C                                                                       6DA31  2
      SUBROUTINE VSTOUT (M,NCW,PCX,BETA,BETASQ,UEI,VEI,WEI,CIR,PVY,PVZ, 6DA31  3
     1NPY,MP1,MMP,NCP,PCPX,PVPY,PVPZ)                                   6DA31  4
      DIMENSION PCX(1),PVY(1),PVZ(1),UEI(1),VEI(1),WEI(1),CIR(1),PCPX(1)6DA31  5
     1,PVPY(1),PVPZ(1)                                                  6DA31  6
  701 FORMAT(1H1,40X,40HVORTEX LATTICE CONTROL POINT COORDINATES/3AX,    6DA31  7
     147HINTERFERENCE VELOCITIES INDUCED AT THESE POINTS/46X,27HCALCULAT6DA31  8
     2ED VORTEX STRENGTHS/48X,24H(WING COORDINATE SYSTEM))              6DA31  9
C                                                                       6DA31 10
C     WING                                                              6DA31 11
C                                                                       6DA31 12
  702 FORMAT(/10X,19HWING CONTROL POINTS/17X,10HROW VORTEX,5X,5HX, FT,6X6DA31 13
     1,5HY, FT,6X,5HZ, FT,6X,6HU/VINF,5X,6HV/VINF,5X,6HW/VINF,3X,10HGAMM6DA31 14
     2A/VINF)                                                           6DA31 15
  703 FORMAT(15X,2I5,3X,7F11.5)                                         6DA31 16
  704 FORMAT(/10X,20HPYLON CONTROL POINTS/17X,10HROW VORTEX,5X,5HX, FT, 6DA31 17
     16X,5HY, FT,6X,5HZ, FT,17X,6HV/VINF,14X,10HGAMMA/VINF)             6DA31 18
  705 FORMAT(15X,2I5,3X,3F11.5,11X,F11.5,11X,F11.5)                     6DA31 19
      WRITE(6,701)                                                      6DA31 20
      WRITE(6,702)                                                      6DA31 21
      DO 1 J=1,M                                                        6DA31 22
      NROW=(J-1)/NCW+1                                                  6DA31 23
      NVOR=J-NCW*(NROW-1)                                               6DA31 24
C                                                                       6DA31 25
C     TRANSFORM TO COMPRESSIBLE SPACE                                   6DA31 26
C                                                                       6DA31 27
      PCXC=PCX(J)*BETA                                                  6DA31 28
      U=UEI(J)/BETASQ                                                   6DA31 29
      V=VEI(J)/BETA                                                     6DA31 30
      W=WEI(J)/BETA                                                     6DA31 31
      C=CIR(J)/BETA                                                     6DA31 32
    1 WRITE(6,703) NROW,NVOR,PCXC,PVY(J),PVZ(J),U,V,W,C                 6DA31 33
      IF (NPY.EQ.0) RETURN                                              6DA31 34
C                                                                       6DA31 35
C     PYLON                                                             6DA31 36
C                                                                       6DA31 37
      WRITE(6,704)                                                      6DA31 38
      DO 2 J=MP1,MMP                                                    6DA31 39
      NROW=(J-M-1)/NCP+1                                                6DA31 40
      NVOR=J-M-NCP*(NROW-1)                                             6DA31 41
      JP=J-M                                                            6DA31 42
C                                                                       6DA31 43
C     TRANSFORM TO COMPRESSIBLE SPACE                                   6DA31 44
C                                                                       6DA31 45
      PCPXC=PCPX(JP)*BETA                                               6DA31 46
      V=VEI(J)/BETA                                                     6DA31 47
      C=CIR(J)/BETA                                                     6DA31 48
    2 WRITE(6,705) NROW,NVOR,PCPXC,PVPY(JP),PVPZ(JP),V,C                6DA31 49
      RETURN                                                            6DA31 50
      END                                                               6DA31 51
```

```
C     SUBROUTINE TO INPUT WING THICKNESS DATA AND LAY OUT STRIPS        6DA32  1
C                                                                       6DA32  2
      SUBROUTINE WTHIN (THETAL,DELTX,CHLOCB,SWPCS,XRC,CHLOCL,Z1,TANPHI, 6DA32  3
     1FACTOR)                                                           6DA32  4
      DIMENSION THETAL(1),DELTX(1),CHLOCB(1),SWPCS(1),XRC(1),CHLOCL(1), 6DA32  5
     1Z1(1),TANPHI(1),FACTOR(1)                                         6DA32  6
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA32  7
     11),XLEL(31),ZLEL(31)                                              6DA32  8
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA32  9
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA32 10
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA32 11
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA32 12
     1,SWPWTI,XLEL,ZLEL                                                 6DA32 13
C                                                                       6DA32 14
C     FORMAT STATEMENTS                                                 6DA32 15
C                                                                       6DA32 16
  701 FORMAT(1015)                                                      6DA32 17
  702 FORMAT(8F10.0)                                                    6DA32 18
  703 FORMAT(//14X14,55H THICKNESS PANELS ARE TO BE LAID OUT ON EACH WIN6DA32 19
     1G PANEL/20X,I3,20H CHORDWISE ROWS WITH,I3,12H IN EACH ROW/21X,43HT6DA32 20
     2HE CHORDWISE ROWS COINCIDE WITH THOSE USED/21X,21HIN THE VORTEX LA6DA32 21
     3TTICE//)                                                          6DA32 22
      READ (5,701) NCWS,NUMIS                                           6DA32 23
      MS=NCWS*MSW                                                       6DA32 24
      WRITE (6,703) MS,MSW,NCWS                                         6DA32 25
      IF (NUMIS.NE.0) GO TO 5                                           6DA32 26
      MN=0                                                              6DA32 27
      DO 1 JNW=1,MS,NCWS                                                6DA32 28
      MN=MN+NCWS                                                        6DA32 29
    1 READ (5,702) (THETAL(J),J=JNW,MN)                                 6DA32 30
      GO TO 10                                                          6DA32 31
    5 READ (5,702)(THETAL(J),J=1,NCWS)                                  6DA32 32
      DO 6 J=2,MSW                                                      6DA32 33
      JJ=(J-1)*NCWS                                                     6DA32 34
      DO 6 K=1,NCWS                                                     6DA32 35
      KK=JJ+K                                                           6DA32 36
    6 THETAL(KK)=THETAL(K)                                              6DA32 37
   10 CONTINUE                                                          6DA32 38
      DO 8120 J=1,MS                                                    6DA32 39
 8120 THETAL(J)=THETAL(J)*BETA                                          6DA32 40
C                                                                       6DA32 41
C     LAY-OUT SPANWISE STRIPS ON THE INCOMPRESSIBLE WING                6DA32 42
C                                                                       6DA32 43
      D=NCWS                                                            6DA32 44
      DO 601 I=2,IMAX                                                   6DA32 45
      DELTX(I)=CHLOCB(I)/D                                              6DA32 46
      DO 720 JWC=1,NCWS                                                 6DA32 47
      JS=(I-2)*NCWS+JWC                                                 6DA32 48
      A=JWC                                                             6DA32 49
      SWPCS(JS)=SWPWLI(I)-((A-0.5)/D)*(SWPWLI(I)-SWPWTI(I))             6DA32 50
      COSSWP=COS(ATAN(SWPCS(JS)))                                       6DA32 51
      XRC(JS)=XLEL(I-1)-((A-0.5)/D)*CHLOCL(I-1)-Y(I-1)*SWPCS(JS)        6DA32 52
      Z1(JS)=ZLEL(I-1)-((-Y(I)+Y(I-1))/2.0)*TANPHI(I)                   6DA32 53
      FACTOR(JS)=(THETAL(JS)*DELTX(I)*COSSWP)/TWOPI                     6DA32 54
  720 CONTINUE                                                          6DA32 55
  601 CONTINUE                                                          6DA32 56
      RETURN                                                            6DA32 57
      END                                                               6DA32 58
```

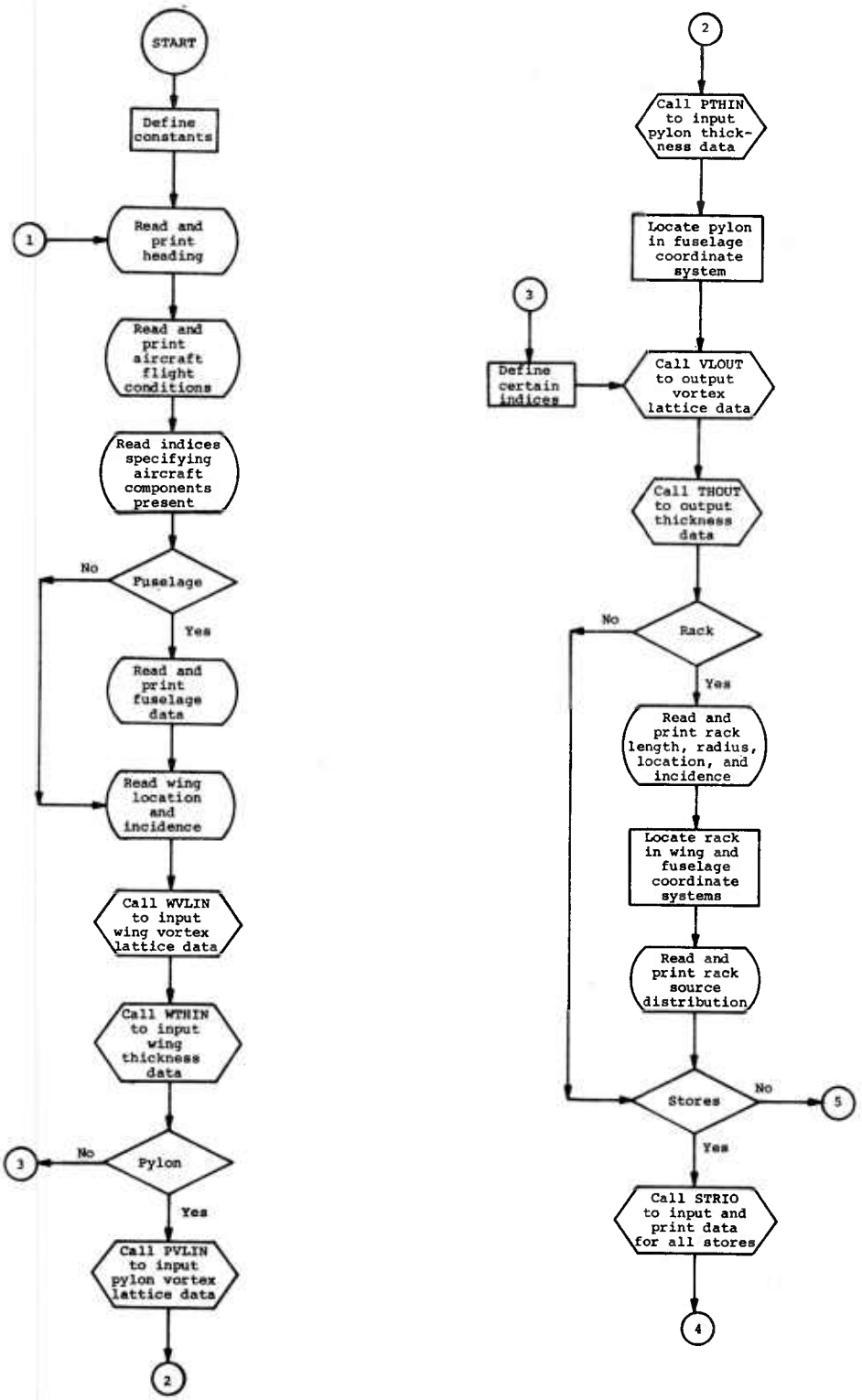

(t) Page 20.

Figure 10.- Continued.

```
C     SUBROUTINE TO INPUT WING VORTEX LATTICE DATA AND LAY OUT VORTICES 6DA33  1
C                                                                       6DA33  2
      SUBROUTINE #VLIN (ALPHAL,CRWI,ALPHLI,CHLOCB,CHLOCL,TANPHI,SUMY,   6DA33  3
     1YLOC,SWPC,SWPV,PHI,SINPHI,COSPHI,SWPVV,SW,PVX,PVY,PVZ,PCX,PTLX,   6DA33  4
     2PTLY,PTLZ)                                                        6DA33  5
      DIMENSION ALPHAL(1),ALPHLI(1),CHLOCB(1),CHLOCL(1),TANPHI(1),      6DA33  6
     1SUMY(1),YLOC(1),SWPC(1),SWPV(1),PHI(1),SINPHI(1),COSPHI(1),       6DA33  7
     2SWPVV(1),SW(1),PVX(1),PVY(1),PVZ(1),PCX(1),PTLX(1),PTLY(1),PTLZ(1)6DA33  8
      DIMENSION Y(31),PSIWLE(31),PSIWTE(31),PHID(31),SWPWLI(31),SWPWTI(36DA33  9
     11),XLEL(31),ZLEL(31)                                             6DA33 10
      COMMON /INDEX/ NCW,MSW,M,IMAX,IP,NCP,MSP,MP,MP1,MMP,KMAX,NCWS,MS, 6DA33 11
     1NCPS,MPS,NSTRS,NPY,NRACK,NFU                                      6DA33 12
      COMMON /CONST/ BETA,DTR,PHIP,TWOPI,RAD                            6DA33 13
      COMMON /WING/ CRW,SSPAN,SREF,SPAN,CAVE,Y,PSIWLE,PSIWTE,PHID,SWPWLI6DA33 14
     1,SWPWTI,XLEL,ZLEL                                                 6DA33 15
C                                                                       6DA33 16
C     FORMAT STATEMENTS                                                 6DA33 17
C                                                                       6DA33 18
  701 FORMAT(8F10.0)                                                    6DA33 19
  702 FORMAT(15X,25HLENGTH OF WING ROOT CHORD/25X,5HCRW =,F10.5,5H FEET/6DA33 20
     115X,13HWING SEMISPAN/25X,7HSSPAN =,F10.5,5H FEET)                 6DA33 21
  703 FORMAT(1015)                                                      6DA33 22
  704 FORMAT(I5,6F10.0)                                                 6DA33 23
  705 FORMAT(//14X,I4,47H VORTICES ARE TO BE LAID OUT ON EACH WING PANEL6DA33 24
     1/20X,I3,20H CHORDWISE ROWS WITH,I3,12H IN EACH ROW//)             6DA33 25
  706 FORMAT(15X,63HSPANWISE LOCATIONS OF TRAILING VORTEX LEGS AND SWEEP6DA33 26
     1 ANGLES AND/20X,43HDIHEDRAL ANGLE OF WING SECTION TO THE RIGHT//  6DA33 27
     226X,38HSPANWISE  LE SWEEP  TE SWEEP  DIHEDRAL/20X,1HI,5X,8HLOCATIO6DA33 28
     3N/28X,4HFEET,5X,7HDEGREES,3X,7HDEGREES,3X,7HDEGREES)              6DA33 29
  707  FORMAT(18X,I3,4X,4F10.5)                                         6DA33 30
       READ (5,701) CRW,SSPAN                                           6DA33 31
       CRW=ABS(CRW)                                                     6DA33 32
       SSPAN=ABS(SSPAN)                                                 6DA33 33
       WRITE (6,702) CRW,SSPAN                                          6DA33 34
       READ (5,703) NCW,MSW                                             6DA33 35
       M=NCW*MSW                                                        6DA33 36
       IMAX=MSW+1                                                       6DA33 37
       DO 1 J=1,IMAX                                                    6DA33 38
    1  READ (5,704) I,Y(I),PSIWLE(I),PSIWTE(I),PHID(I)                  6DA33 39
       WRITE (6,705) M,MSW,NCW                                          6DA33 40
       WRITE (6,706)                                                    6DA33 41
       DO 2 J=1,IMAX                                                    6DA33 42
    2  WRITE (6,707) J,Y(J),PSIWLE(J),PSIWTE(J),PHID(J)                 6DA33 43
C                                                                       6DA33 44
C     INPUT TWIST AND CAMBER DISTRIBUTION IF ANY                        6DA33 45
C                                                                       6DA33 46
       DO 3 J=1,M                                                       6DA33 47
    3  ALPHAL(J)=0.0                                                    6DA33 48
       READ (5,703) NTAC,NUNI                                           6DA33 49
       IF (NTAC.EQ.0) GO TO 10                                          6DA33 50
       IF (NUNI.NE.0) GO TO 5                                           6DA33 51
       MN=0                                                             6DA33 52
       DO 4 JNW=1,M,NCW                                                 6DA33 53
       MN=MN+NCW                                                        6DA33 54
    4  READ (5,701) (ALPHAL(J),J=JNW,MN)                                6DA33 55
       GO TO 10                                                         6DA33 56
    5  READ (5,701) (ALPHAL(J),J=1,NCW)                                 6DA33 57
       DO 6 J=2,MSW                                                     6DA33 58
       JJ=(J-1)*NCW                                                     6DA33 59
       DO 6 K=1,NCW                                                     6DA36 60
       KK=JJ+K                                                          6DA33 61
    6  ALPHAL(KK)=ALPHAL(K)                                             6DA33 62
C                                                                       6DA33 63
C     LAY OUT WING VORTICES                                             6DA33 64
C                                                                       6DA33 65
   10  CRWI=CRW/BETA                                                    6DA33 66
       DO 8119 I=1,IMAX                                                 6DA33 67
       SWPWLI(I)=(TAN(PSIWLE(I)*DTR))/BETA                              6DA33 68
 8119  SWPWTI(I)=(TAN(PSIWTE(I)*DTR))/BETA                              6DA33 69
       DO 8123 J=1,M                                                    6DA33 70
 8123  ALPHLI(J)=ALPHAL(J)*BETA                                         6DA33 71
C                                                                       6DA33 72
C     LAY OUT HORSESHOE VORTEX BOUNDLEG MIDPOINTS AND CONTROL POINTS    6DA33 73
C     COORDINATES ON THE INCOMPRESSIBLE WING                            6DA33 74
C                                                                       6DA33 75
      D=NCW                                                             6DA33 76
      CHLOCH(1)=0.0                                                     6DA33 77
      CHLOCL(1)=CRWI                                                    6DA33 78
      XLEL(1)=0.0                                                       6DA33 79
      ZLEL(1)=0.0                                                       6DA33 80
      SREF=0.0                                                          6DA33 81
      DO 601 I=2,IMAX                                                   6DA33 82
      TANPHI(I)=TAN(PHID(I)*DTR)                                        6DA33 83
C                                                                       6DA33 84
C     XLEL AND ZLEL ARE THE HORSESHOE VORTEX LEFT TAIL COORDINATES AT   6DA33 85
C     THE WING LEADING EDGE                                             6DA33 86
C                                                                       6DA33 87
      XLEL(I)=-(-Y(I)+Y(I-1))*SWPWLI(I)+XLEL(I-1)                       6DA33 88
      ZLEL(I)=-(-Y(I)+Y(I-1))*TANPHI(I)+ZLEL(I-1)                       6DA33 89
      SUMY(I)=(Y(I)+Y(I-1))/2.0                                         6DA33 90
      YLOC(I)=SUMY(I)/SSPAN                                             6DA33 91
      CHLOCB(I)=CHLOCL(I-1)-((-Y(I)+Y(I-1))/2.0)*(SWPWLI(I)-SWPWTI(I))  6DA33 92
      CHLOCL(I)=CHLOCL(I-1)-(-Y(I)+Y(I-1))*(SWPWLI(I)-SWPWTI(I))        6DA33 93
      SREF=SREF+(CHLOCL(I-1)+CHLOCL(I))*(-Y(I)+Y(I-1))                  6DA33 94
      DO 720 JCW=1,NCW                                                  6DA33 95
      A=JCW                                                             6DA33 96
      J=(I-2)*NCW+JCW                                                   6DA33 97
      SWPC(J)=SWPWLI(I)-((A-0.25)/D)*(SWPWLI(1)-SWPWTI(1))              6DA33 98
      SWPV(J)=SWPWLI(I)-((A-0.75)/D)*(SWPWLI(1)-SWPWTI(1))              6DA33 99
      PHI(J)=PHID(I)*DTR                                                6DA33100
      SINPHI(J)=SIN(PHI(J))                                             6DA33101
      COSPHI(J)=COS(PHI(J))                                             6DA33102
C                                                                       6DA33103
C     SWPVV AND SW ARE HORSESHOE VORTEX BOUNDLEG SWEEP AND HALFWIDTH    6DA33104
C     MEASURED IN INCOMPRESSIBLE WING CHORDAL PLANE                     6DA33105
C                                                                       6DA33106
      SWPVV(J)=SWPV(J)*COSPHI(J)                                        6DA33107
      SW(J)=(-Y(I)+Y(I-1))/(2.0*COSPHI(J))                              6DA33108
      PVX(J)=XLEL(I-1)-((A-0.75)*(CHLOCL(I-1)/D))-((-Y(1)+Y(I-1))/2.0)*S6DA33109
     1WPV(J)                                                            6DA33110
      PVY(J)=SUMY(I)                                                    6DA33111
      PVZ(J)=ZLEL(I-1)-((-Y(I)+Y(I-1))/2.0)*TANPHI(I)                   6DA33112
      PCX(J)=XLEL(I-1)-((A-0.25)*(CHLOCL(I-1)/D))-((-Y(1)+Y(I-1))/2.0)*S6DA33113
     1WPC(J)                                                            6DA33114
      PTLX(J)=XLEL(I-1)-((A-0.25)*(CHLOCL(I-1)/D))- (-Y(I)+Y(I-1))*     6DA33115
     1SWPC(J)                                                           6DA33116
      PTLY(J)=Y(I)                                                      6DA33117
      PTLZ(J)=ZLEL(I-1)-(-Y(I)+Y(I-1))*TANPHI(I)                        6DA33118
  720 CONTINUE                                                          6DA33119
  601 CONTINUE                                                          6DA33120
C                                                                       6DA33121
C     COMPUTE INCOMPRESSIBLE AVERAGE CHORD, SREF IS INCOMPRESSIBLE      6DA33122
C     WING AREA                                                         6DA33123
C                                                                       6DA33124
      SPAN=2.0*SSPAN                                                    6DA33125
      CAVE=SREF/SPAN                                                    6DA33126
      RETURN                                                            6DA33127
      END                                                               6DA33128
```

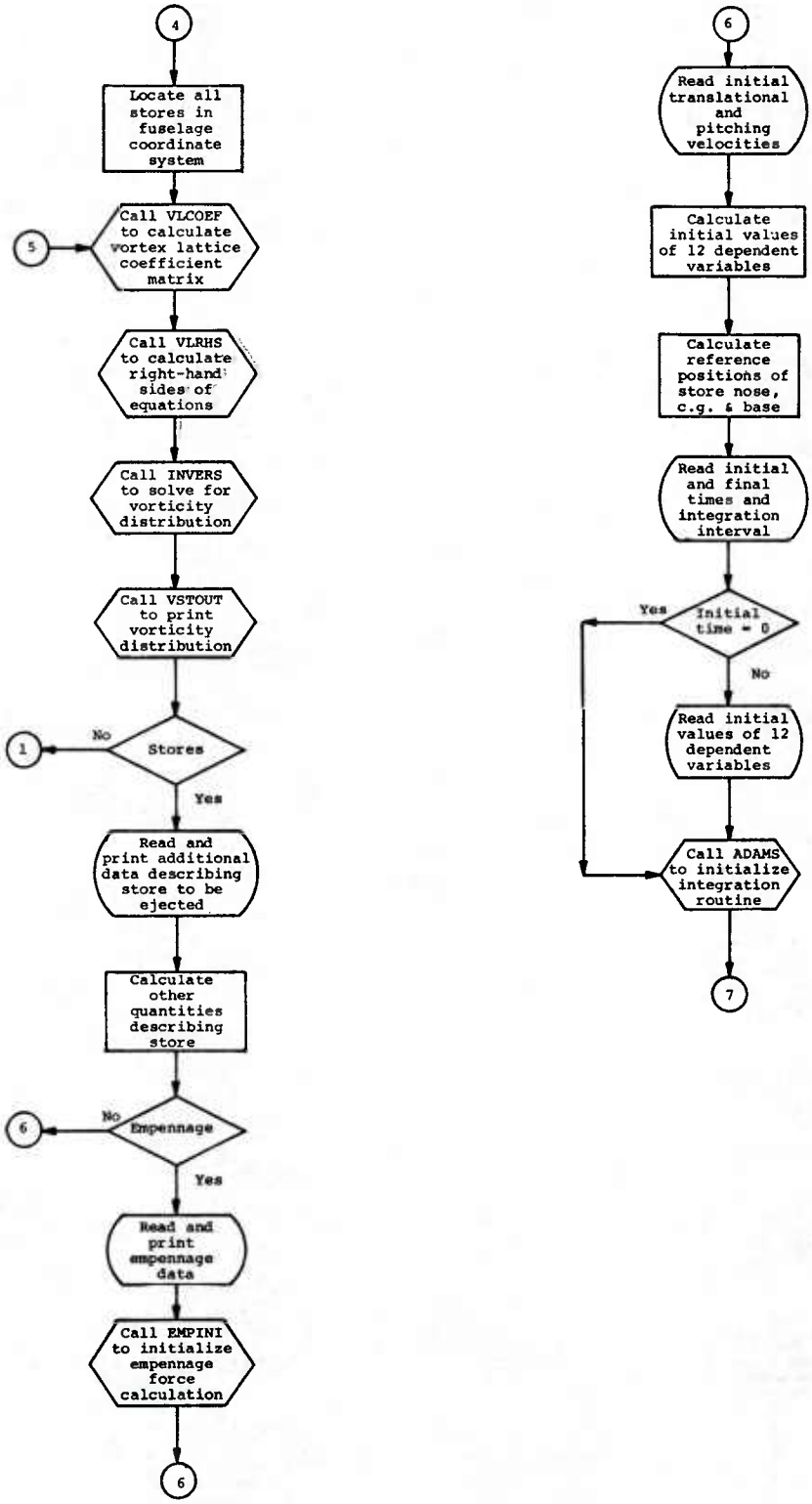

(u) Page 21.

Figure 10.- Concluded.



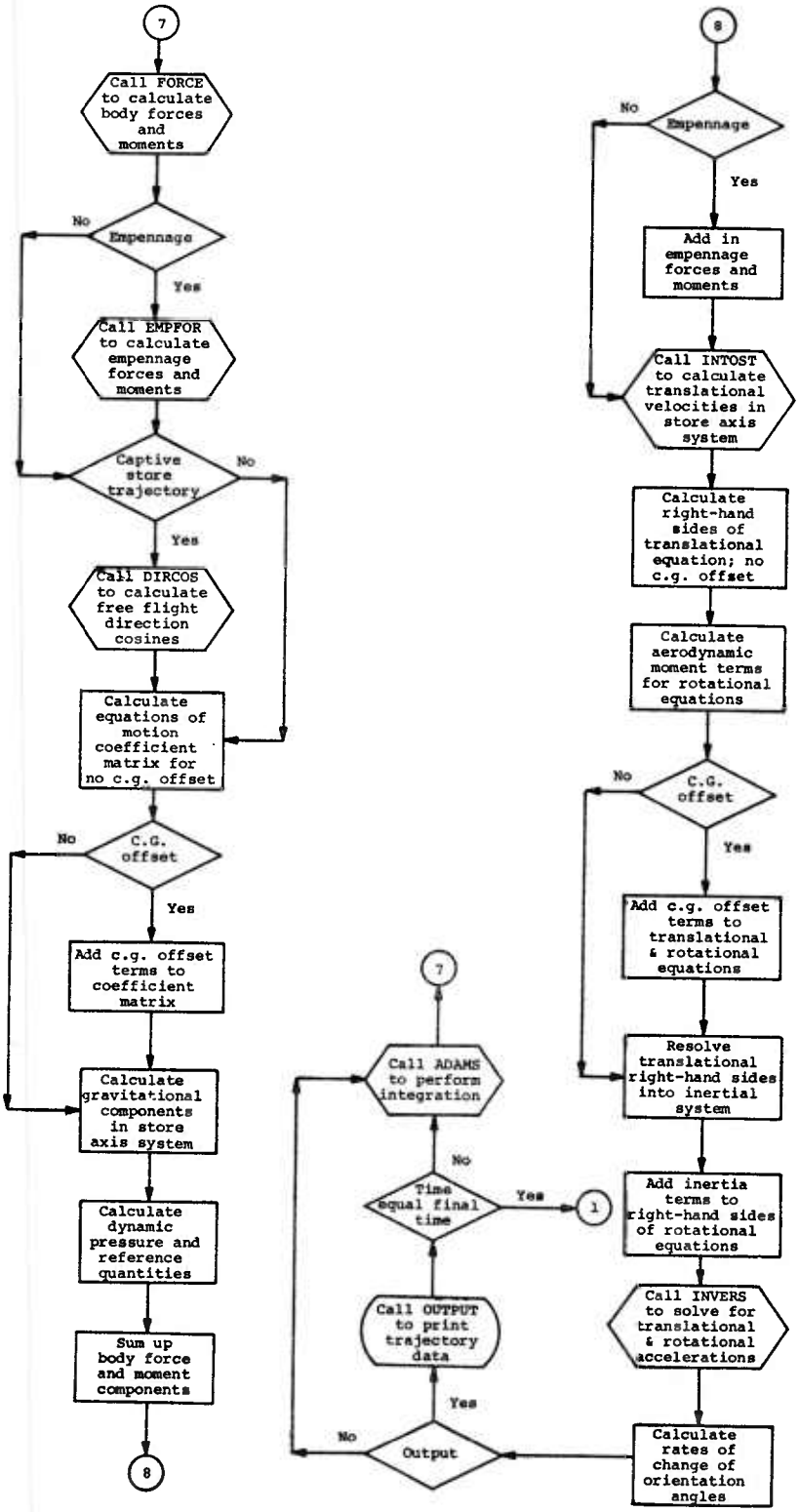
(a) Page 1.

Figure 11.- General flow chart of trajectory program.



(b) Page 2.

Figure 11.- Continued.



(c) Page 3.

Figure 11.- Concluded.

Item No. 1 (1 card)

Variable	NCARDS
Card Column	5
Format Type	I

Item No. 2 (NCARDS cards)

Variable	HEAD	80
Card Column	1	
Format Type	A	

Item No. 3 (1 card)

Variable	ALFAC	GAMF	FMACH	RHO	VINF
Card Column	10	20	30	40	50
Format Type	F	F	F	F	F

Item No. 4 (1 card)

Variable	NFU	NPY	NRACK	NSTRS
Card Column	5	10	15	20
Format Type	I	I	I	I

Item No. 5 (1 card, omit if NFU = 0)

Variable	FLTHC	FRMAX
Card Column	10	20
Format Type	F	F

Item No. 6 (1 card, omit if NFU = 0)

Variable	NFSOR
Card Column	5
Format Type	I

Item No. 7 (NFSOR values, six to a card. Omit if NFU = 0)

Variable	FXL(1)	FXL(2)	FXL(3)	...	FXL(NFSOR)	
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

(a) Page 1.

Figure 12.- Trajectory program input format.

Item No. 8 (NFSOR values, six to a card. Omit if NFU = 0)

Variable	FSOR(1)	FSOR(2)	...	FSOR(NFSOR)		
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

Item No. 9 (1 card)

Variable	XBWOC	ZBWO	WIC
Card Column	10	20	30
Format Type	F	F	F

Item No. 10 (1 card)

Variable	CRW	SSPAN
Card Column	10	20
Format Type	F	F

Item No. 11 (1 card)

Variable	NCW	MSW
Card Column	5	10
Format Type	I	I

Item No. 12 (I = 1 to MSW+1; MSW+1 cards)

Variable	I	Y(I)	PSIWLE(I)	PSIWTE(I)	PHID(I)
Card Column	5	15	25	35	45
Format Type	I	F	F	F	F

Item No. 13 (1 card)

Variable	NTAC	NUNI
Card Column	5	10
Format Type	I	I

Item No. 14 (NCW values, eight to a card. Omit if NTAC = 0. One set of cards if NUNI = 1; MSW sets if NUNI = 0.

Variable	ALPHAL(1)	ALPHAL(2)	...	ALPHAL(NCW)				
Card Column	10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

(b) Page 2.

Figure 12.- Continued.

Item No. 15 (1 card)

Variable	NCWS	NUNIS
Card Column	5	10
Format Type	I	I

Item No. 16 (NCWS values, eight to a card. One set of cards if NUNIS = 1; NSW sets if NUNIS = 0.)

Variable	THETAL(1)	THETAL(2)	...	THETAL(NCWS)				
Card Column	10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

Item No. 17 (1 card. Omit if NPY = 0.)

Variable	IP	PSIPLE	PSIPTE	CRP	H	XPLE
Card Column	5	15	25	35	45	55
Format Type	I	F	F	F	F	F

Item No. 18 (1 card. Omit if NPY = 0.)

Variable	NCP	MSP
Card Column	5	10
Format Type	I	I

Item No. 19 (K = 1 to MSP+1; MSP+1 cards. Omit if NPY = 0.)

Variable	K	Z(K)
Card Column	5	15
Format Type	I	F

Item No. 20 (1 card. Omit if NPY = 0.)

Variable	NCPS	NUNIP
Card Column	5	10
Format Type	I	I

Item No. 21 (NCPS values, eight to a card. Omit if NPY = 0. One set of cards if NUNIP = 1; MSP sets if NUNIP = 0.)

Variable	THETPL(1)	THETPL(2)	...	THETPL(NCPS)				
Card Column	10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

(c) Page 3.

Figure 12.- Continued.

Item No. 22 (1 card. Omit if NRACK = 0.)

Variable	RLTHC	RRMAX	XRNC	ZRN	RIC
Card Column	10	20	30	40	50
Format Type	F	F	F	F	F

Item No. 23 (1 card. Omit if NRACK = 0.)

Variable	NRSOR
Card Column	5
Format Type	I

Item No. 24 (NRSOR values, six to a card. Omit if NRACK = 0.)

Variable	RXL(1)	RXL(2)	...	RXL(NRSOR)		
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

Item No. 25 (NRSOR values, six to a card. Omit if NRACK = 0.)

Variable	RSOR(1)	RSOR(2)	...	RSOR(NRSOR)		
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

Note: If NSTRS = 0, this completes the input data. Since no stores are present, NSTRS = 0, a trajectory cannot be run.

Item No. 26 (J = 1 to NSTRS; NSTRS cards)

Variable	NUMSTR(J)	NSHAPE(J)	SLTHC(J)	SRMAX(J)	XSNC(J)	YSN(J)	ZSN(J)	SIC(J)
Card Column	5	10	20	30	40	50	60	70
Format Type	I	I	F	F	F	F	F	F

Item No. 27 (1 card)

Variable	NSHPT
Card Column	5
Format Type	I

(d) Page 4.

Figure 12.- Continued.

Item No. 28* (1 card)

Variable	MSHAPE	MSOR
Card Column	5	10
Format Type	I	I

Item No. 29* (MSOR values, six to a card)

Variable	DUMX(1)	DUMX(2)	...	DUMX(MSOR)		
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

Item No. 30* (MSOR values, six to a card)

Variable	DUMQ(1)	DUMQ(2)	...	DUMQ(MSOR)		
Card Column	12	24	36	48	60	72
Format Type	E	E	E	E	E	E

Item No. 31 (1 card)

Variable	NEJECT	NSEG	NSEGXO	NGAM	NPOLY	NROLL	NEMP	NDAMP
Card Column	5	10	15	20	25	30	35	40
Format Type	I	I	I	I	I	I	I	I

Item No. 32 (1 card)

Variable	SMASS	FIXX	FIYY	FIZZ	FIYZ	FIXZ	FIXY
Card Column	10	20	30	40	50	60	70
Format Type	F	F	F	F	F	F	F

Item No. 33 (1 card)

Variable	XMOM	XBAR	YBAR	ZBAR
Card Column	10	20	30	40
Format Type	F	F	F	F

*If NSHPT > 1, repeat items 28 through 30, in sequence, NSHPT times.

(e) Page 5.

Figure 12.- Continued.

Item No. 34 (1 card)

Variable	XEND(1)	XEND(2)	...	XEND(NPOLY)			
Card Column	10	20	30	40	50	60	70
Format Type	F	F	F	F	F	F	F

Item No. 35 (J = 1 to NPOLY; NPOLY cards)

Variable	COEF(J,1)	COEF(J,2)	COEF(J,3)	COEF(J,4)	COEF(J,5)	COEF(J,6)	COEF(J,7)
Card Column	10	20	30	40	50	60	70
Format Type	F	F	F	F	F	F	F

Item No. 36 (1 card)

Variable	CA	CDC
Card Column	10	20
Format Type	F	F

Item No. 37 (1 card. Omit if NEMP = 0)

Variable	IPLNR	MSF
Card Column	5	10
Format Type	I	I

Item No. 38 (1 card. Omit if NEMP = 0)

Variable	XTAIL	RADAV	FINSS	PHIROL	CLALPH
Card Column	10	20	30	40	50
Format Type	F	F	F	F	F

Item No. 39 (1 card)

Variable	VZERO	VAR(5)
Card Column	10	20
Format Type	F	F

(f) Page 6.

Figure 12.- Continued.

Item No. 40 (1 card)

Variable	DTIME	TIMEI	TIMEF
Card Column	10	20	30
Format Type	F	F	F

Item No. 41 (2 cards. Omit if TIMEI = 0)

Variable	VAR(1)	VAR(2)	...	VAR(12)				
Card Column	10	20	30	40	50	60	70	80
Format Type	F	F	F	F	F	F	F	F

(g) Page 7.

Figure 12.- Concluded.

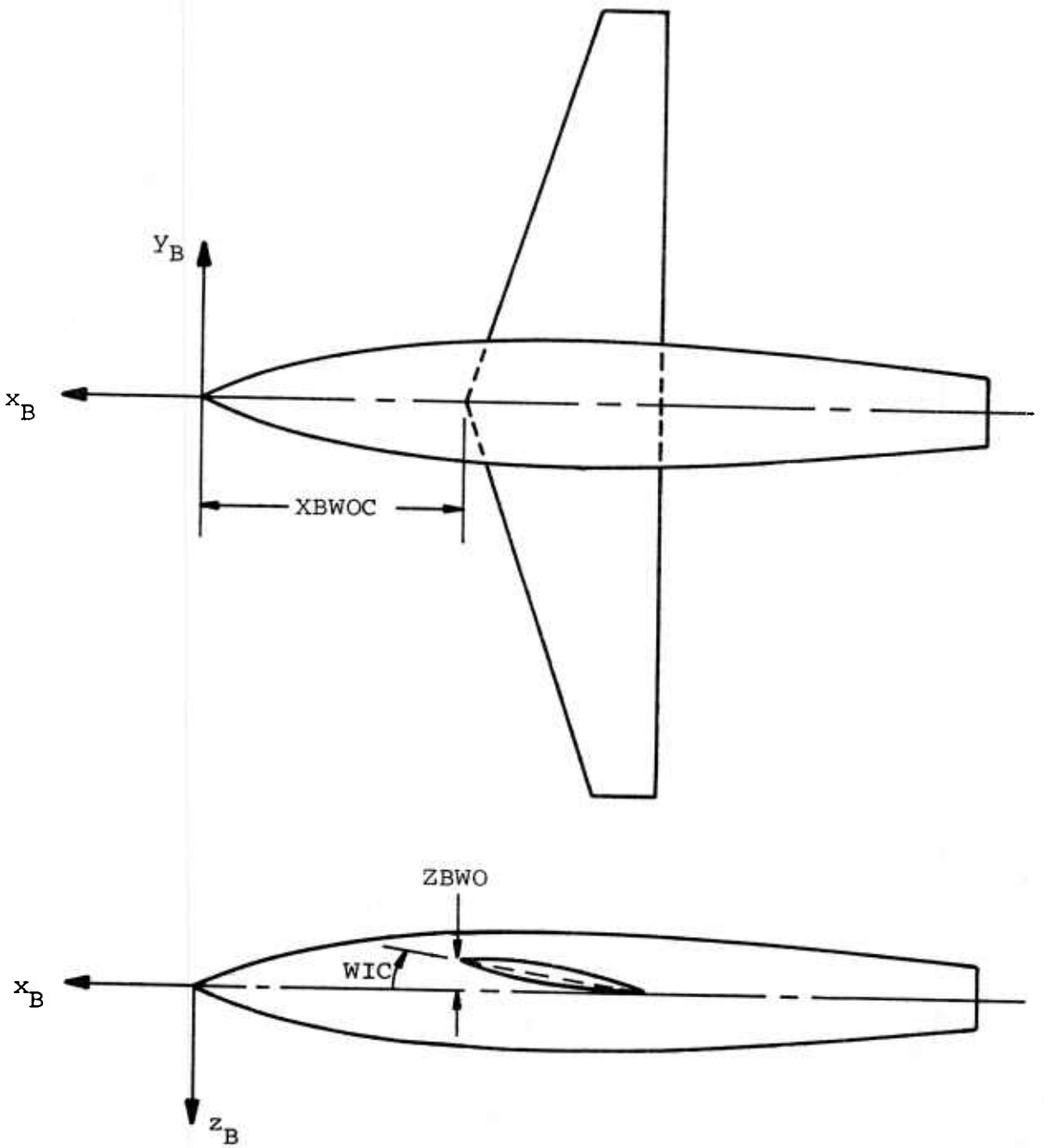


Figure 13.- Specification of wing location relative to fuselage nose and incidence angle.

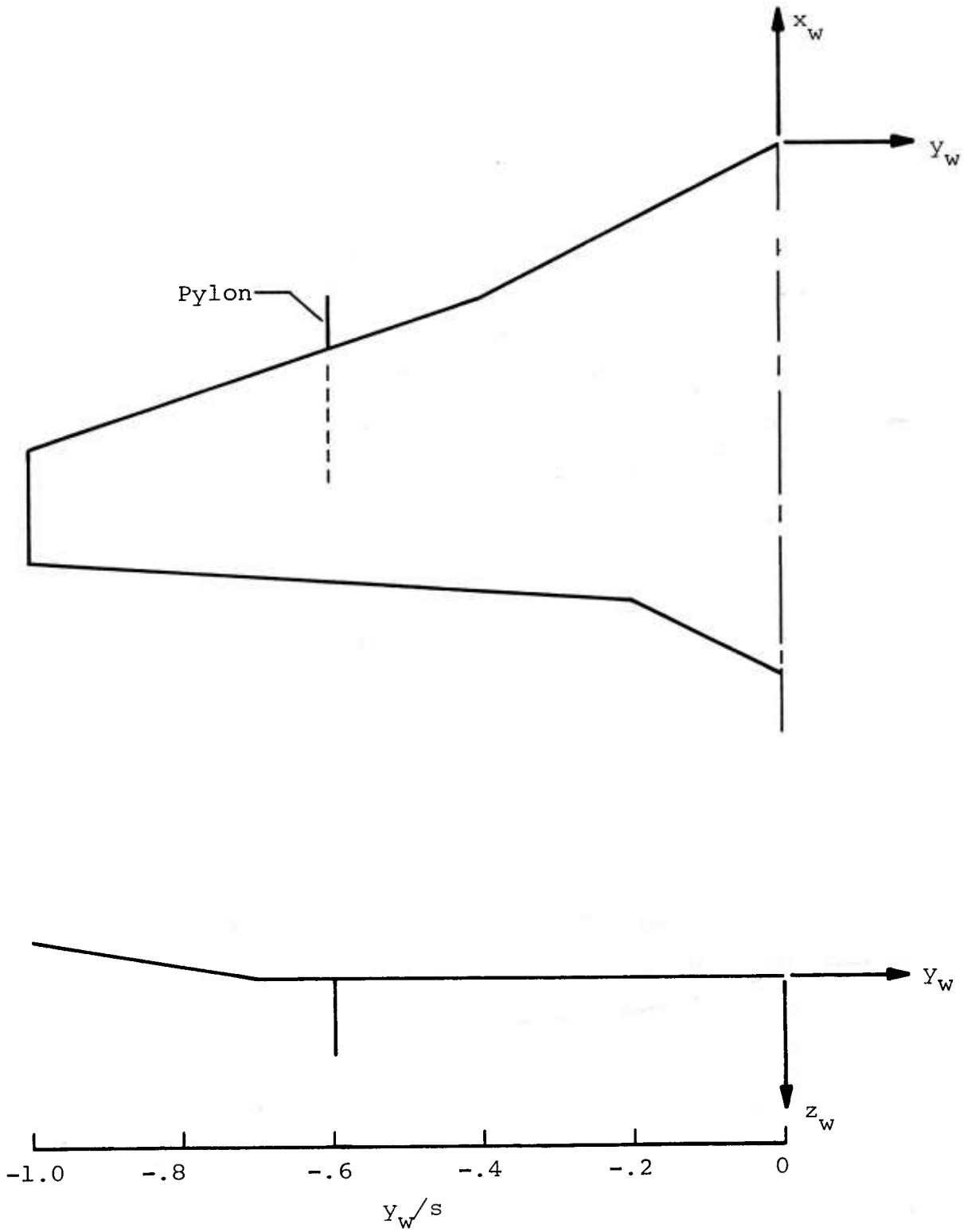
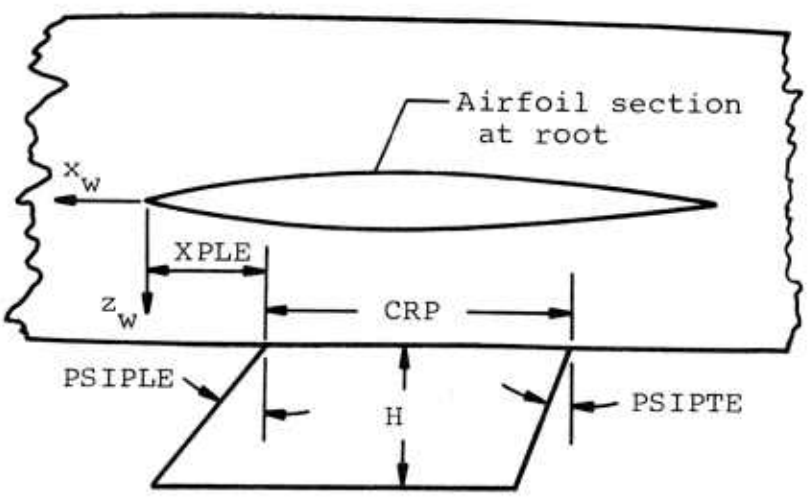
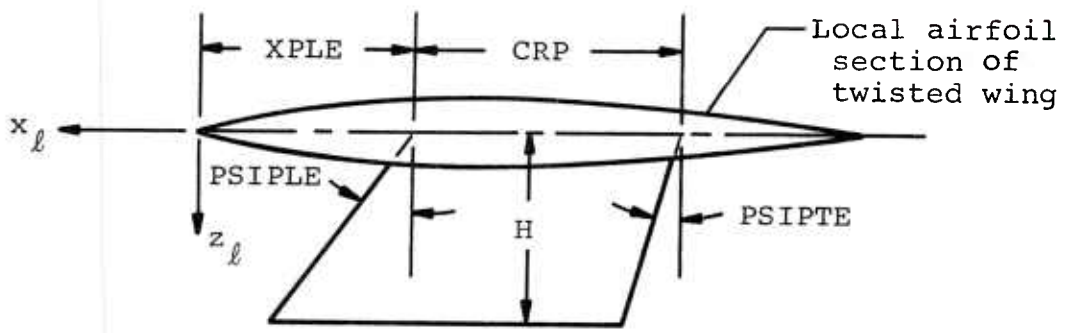


Figure 14.- Example wing.



(a) Pylon under fuselage centerline.



(b) Pylon under wing.

Figure 15.- Variables describing and locating pylon, input data item number 17.

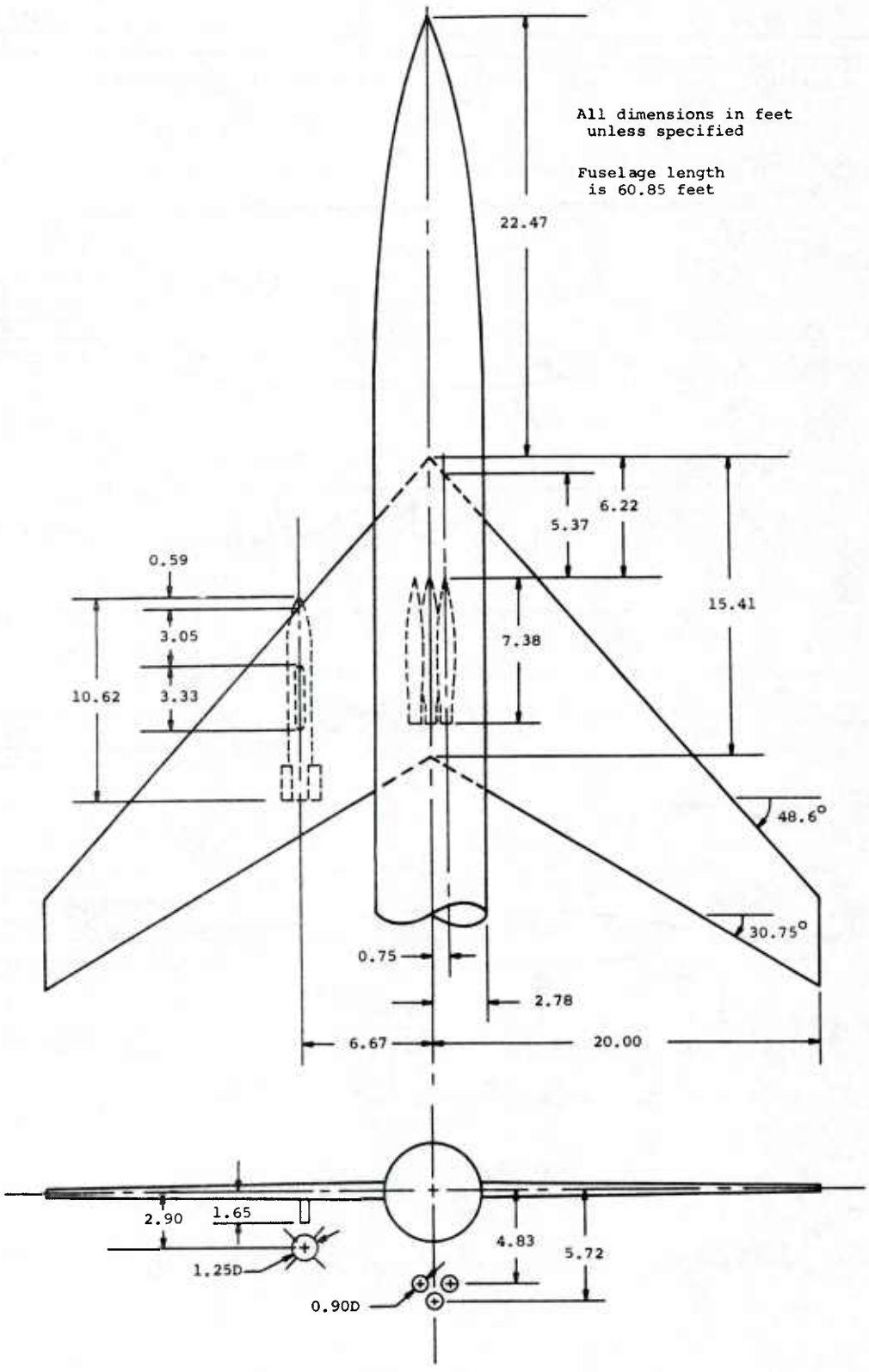


Figure 16.- Configuration for sample trajectory number 1.

		Item No.
13		1
SAMPLE TRAJECTORY CALCULATION NUMBER 1 AIRCRAFT AND STORES ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK MODELS SCALED UP BY A FACTOR OF 20 TO APPROXIMATE A FULL SCALE AIRCRAFT THERE IS A FINNED OGIVE-CYLINDER STORE ON A PYLON AT THE 1/3 SEMISPAN LOCATION OF THE LEFT WING PANEL THERE ARE ALSO THREE SMALL FINLESS BOATTAILED STORES GROUPED AS A TEP CLUSTER UNDER THE FUSELAGE THE STORE UNDER THE WING IS EJECTED WITH THE TRAJECTORY STARTING ONE RADIUS BELOW THE CARRIAGE POSITION IT IS A FREE-FLIGHT TRAJECTORY, NOT A CAPTIVE STORE TRAJECTORY ROLLING MOMENT IS CALCULATED DAMPING IS INCLUDED		2
4.0 0.0 0.4 .0020482 440.7		3
1 1 0 4		4
60.85 2.7834		5
58		6
2.0000-03 2.5300-03 3.2006-03 4.0487-03 5.1206-03 6.4745-03 8.1831-03 1.0337-02 1.3048-02 1.6456-02 2.0729-02 2.6072-02 3.2730-02 4.0993-02 5.1192-02 6.3697-02 7.8907-02 9.7224-02 1.1902-01 1.4458-01 1.7406-01 2.0737-01 2.4415-01 2.8372-01 3.2508-01 3.6696-01 4.0885-01 4.5073-01 4.9262-01 5.3450-01 5.7639-01 6.1827-01 6.6016-01 7.0204-01 7.4393-01 7.8581-01 8.2745-01 8.6805-01 9.0687-01 9.4326-01 9.7675-01 1.0070-00 1.0336-00 1.0573-00 1.0776-00 1.0948-00 1.1094-00 1.1215-00 1.1316-00 1.1399-00 1.1467-00 1.1522-00 1.1567-00 1.1603-00 1.1632-00 1.1656-00 1.1675-00 1.1690-00		7
6.0353-06 -5.4782-06 3.5398-06 -2.1785-06 1.6162-06 -6.6962-07 1.0445-06 3.1040-07 1.3737-06 1.6004-06 2.8780-06 4.2266-06 6.6436-06 9.9387-06 1.4815-05 2.1403-05 3.0085-05 4.0582-05 5.2075-05 6.2487-05 6.8767-05 6.2946-05 7.3261-05 4.5069-06 -7.6829-07 -1.2766-05 9.9914-06 -1.1501-05 1.0717-05 -1.1060-05 1.1063-05 -1.0703-05 1.1555-05 -9.8993-06 1.6496-05 -1.3298-05 -3.1426-05 -4.5538-05 -5.3835-05 -5.6492-05 -5.3967-05 -4.8229-05 -4.0372-05 -3.2497-05 -2.4705-05 -1.8652-05 -1.3021-05 -9.7406-06 -5.9456-06 -5.1105-06 -1.9394-06 -3.3603-06 7.1284-07 -3.6458-06 3.4910-06 -6.0077-06 8.0640-06 -9.4139-06		8
-22.406 0.0 0.0		9
15.412 20.0		10
8 5		11
1 0.0 0.0 0.0 0.0 2 -3.33333 48.6 30.75 0.0 3 -6.66667 48.6 30.75 0.0 4 -10.00000 48.6 30.75 0.0 5 -15.00000 48.6 30.75 0.0 6 -20.00000 48.6 30.75 0.0		12
0		13
16 1		15
.18074 .09400 .06400 .04460 .02800 .01955 -.00122 -.01341 -.02561 -.03782 -.05005 -.06000 -.06600 -.06719 -.06719 -.06719		16
3 0.0 0.0 3.33333 1.652 -3.046		17
2 2		18
1 0.0 2 0.826 3 1.652		19
60 1		20
1.7406 .7502 .3536 .06686 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 -.06686 -.3536 -.7502 -1.7406		21
10 2 10.625 0.625 0.59333 -6.66667 2.902 0.0 20 5 7.38333 0.44667 -6.22083 0.0 5.71666 0.0 21 5 7.38333 0.44667 -5.37033 -0.75 4.83333 0.0 22 5 7.38333 0.44667 -5.37033 0.75 4.83333 0.0		26
2		27

(a) Page 1.

Figure 17.- Input data for sample trajectory calculation number 1.

						Item No.
2 51						28
2.0000-03	2.6473-03	3.5132-03	4.6705-03	6.2149-03	8.2721-03	
1.1006-02	1.4626-02	1.9406-02	2.5661-02	3.3810-02	4.4516-02	
5.7699-02	7.4485-02	9.5145-02	1.1999-01	1.4904-01	1.8194-01	
2.1781-01	2.5531-01	2.9305-01	3.3079-01	3.6852-01	4.0626-01	29
4.4400-01	4.8173-01	5.1947-01	5.5721-01	5.9494-01	6.3268-01	
6.7042-01	7.0815-01	7.4589-01	7.8363-01	8.2136-01	8.5910-01	
8.9684-01	9.3457-01	9.7231-01	1.0100-00	1.0477-00	1.0840-00	
1.1171-00	1.1459-00	1.1697-00	1.1884-00	1.2025-00	1.2127-00	
1.2200-00	1.2250-00	1.2284-00				
4.8513-06	-4.3215-06	2.4426-06	-7.1054-07	1.2638-06	1.0935-06	
2.5749-06	4.3291-06	7.8030-06	1.3510-05	2.3018-05	3.7947-05	
5.9954-05	8.9502-05	1.2214-04	1.5482-04	1.2820-04	2.0261-04	
-5.0476-05	-1.1398-04	1.1594-04	-1.2468-04	1.2050-04	-1.2326-04	30
1.2144-04	-1.2266-04	1.2185-04	-1.2235-04	1.2211-04	-1.2213-04	
1.2233-04	-1.2188-04	1.2263-04	-1.2149-04	1.2318-04	-1.2063-04	
1.2450-04	-1.1674-04	1.1695-04	1.1480-05	-1.1924-04	-1.7271-04	
-1.7495-04	-1.3912-04	-9.3587-05	-5.4285-05	-2.9966-05	-1.2530-05	
-1.0227-05	4.6640-06	-1.1713-05				
5 44						28
2.0000-03	2.8692-03	4.1068-03	5.8625-03	8.3399-03	1.1810-02	
1.6619-02	2.3192-02	3.2007-02	4.3538-02	5.8146-02	7.5981-02	
9.7189-02	1.2159-01	1.4862-01	1.7742-01	2.0779-01	2.3980-01	
2.7354-01	3.0909-01	3.4653-01	3.8580-01	4.2644-01	4.6791-01	
5.0956-01	5.5081-01	5.9097-01	6.2948-01	6.6584-01	6.9965-01	29
7.3065-01	7.5881-01	7.8492-01	8.0970-01	8.3372-01	8.5746-01	
8.8119-01	9.0493-01	9.2867-01	9.5241-01	9.7614-01	9.9988-01	
1.0236-00	1.0435-00					
3.8950-06	-2.9405-06	1.8989-06	5.6064-07	2.6288-06	4.7915-06	
9.7339-06	1.8419-05	3.2418-05	5.3617-05	5.6472-05	9.3568-05	
8.9716-05	9.5866-05	-5.8866-05	1.3457-04	-2.0499-05	1.2904-04	
1.0512-05	1.3466-04	9.0154-05	-2.6121-05	1.2754-04	-1.0693-04	30
6.5056-05	-1.7406-04	3.1092-05	-2.3365-04	4.9612-05	-2.8651-04	
8.2015-05	-2.0799-04	1.6871-04	-2.1783-04	2.2493-04	-2.1059-04	
2.1369-04	-2.0999-04	2.1386-04	-2.0582-04	1.9470-04	2.2062-05	
-4.1387-04	1.8464-05					
10 20	20 0	2 1	1 1			31
15.53	8.0	80.0	80.0	0.0	0.0	0.0	32
-5.3125	0.0	0.0	0.0				33
0.2353	1.1						34
-0.4413	-1.0	0.4706	0.1947			1.0	35
0.05882							
0.4	0.0						36
0 5							37
-9.376	0.625	1.45833	45.0	3.22			38
10.0	0.0						39
0.05	0.0	0.6					40

(b) Page 2.

Figure 17.- Concluded.

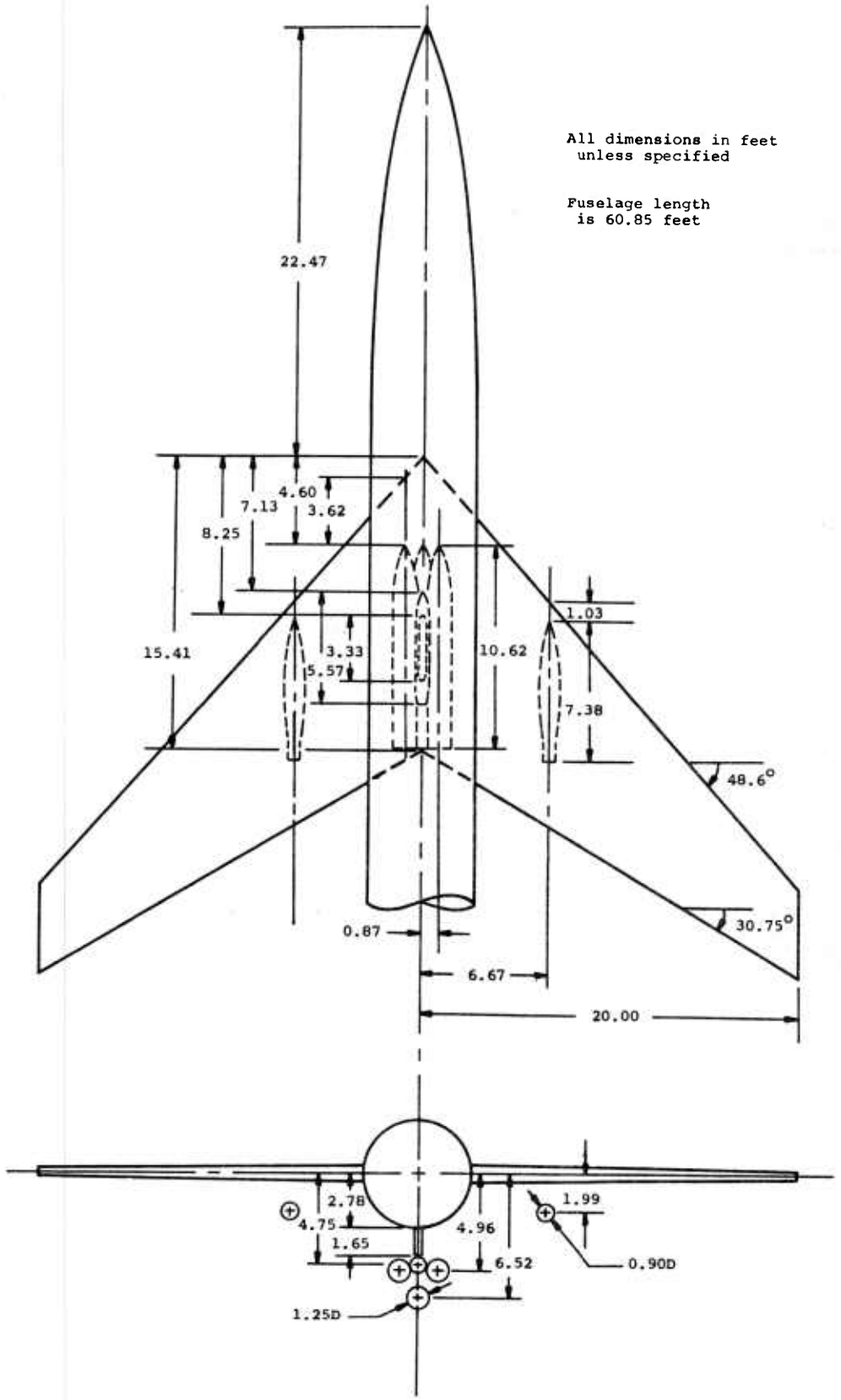


Figure 18.- Configuration for sample trajectory number 2.

```
                                                                                    Item No.
13                                                                                     1
SAMPLE TRAJECTORY CALCULATION NUMBER 2
    AIRCRAFT AND STORES ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
        PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
    MODELS SCALED UP BY A FACTOR OF 20 TO APPROXIMATE A FULL SCALE AIRCRAFT
    THERE IS A SMALL FINLESS BOATTAILED STORE AT THE 1/3 SEMISPAN LOCATION
        OF BOTH WING PANELS
    THERE ALSO ARE THREE FINLESS OGIVE-CYLINDER STORES GROUPED ON A                    2
        TER-RACK/PYLON UNDER THE FUSELAGE
    THE BOTTOM STORE OF THE TER GROUPING IS THE STORE EJECTED WITH THE
        TRAJECTORY STARTING ONE RADIUS BELOW THE CARRIAGE POSITION
    IT IS A FREE-FLIGHT TRAJECTORY, NOT A CAPTIVE STORE TRAJECTORY
    DAMPING IS INCLUDED
    THE AIRCRAFT IS DIVING AT A FLIGHT PATH ANGLE OF -30 DEGREES
6.0      -30.0       0.4      .0020482 440.7                                           3
 1    1    1    5                                                                      4
60.85       2.7834                                                                     5
58                                                                                     6
2.0000-03   2.5300-03   3.2006-03   4.0487-03   5.1206-03   6.4745-03
8.1831-03   1.0337-02   1.3048-02   1.6456-02   2.0729-02   2.6072-02
3.2730-02   4.0993-02   5.1192-02   6.3697-02   7.8907-02   9.7224-02
1.1902-01   1.4456-01   1.7406-01   2.0737-01   2.4415-01   2.8372-01
3.2506-01   3.6696-01   4.0885-01   4.5073-01   4.9262-01   5.3450-01
5.7639-01   6.1827-01   6.6016-01   7.0204-01   7.4393-01   7.8581-01                  7
8.2745-01   8.6805-01   9.0687-01   9.4326-01   9.7673-01   1.0070-00
1.0338-00   1.0573-00   1.0776-00   1.0948-00   1.1094-00   1.1215-00
1.1316-00   1.1399-00   1.1467-00   1.1522-00   1.1567-00   1.1603-00
1.1632-00   1.1656-00   1.1675-00   1.1690-00
6.0353-06  -5.4782-06   3.5398-06  -2.1785-06   1.6162-06  -6.6962-07
1.0445-06   3.1040-07   1.3737-06   1.6004-06   2.8780-06   4.2266-06
6.6436-06   9.9387-06   1.4813-05   2.1403-05   3.0083-05   4.0582-05
5.2073-05   6.2487-05   6.8767-05   6.2946-05   7.3261-05   4.5069-06
-7.6829-07 -1.2766-05   9.9914-06  -1.1501-05   1.0717-05  -1.1060-05                  8
1.1063-05  -1.0703-05   1.1555-05  -9.8993-06   1.6496-05  -1.3296-05
-3.1426-05 -4.5538-05  -5.3835-05  -5.6492-05  -5.3967-05  -4.8229-05
-4.0372-05 -3.2497-05  -2.4705-05  -1.8652-05  -1.3021-05  -9.7406-06
-5.9458-06 -5.1105-06  -1.9394-06  -3.3603-06   7.1284-07  -3.6458-06
3.4910-06  -6.0077-06   8.0640-06  -9.4139-06
-22.466       0.0          0.0                                                         9
15.412      20.0                                                                      10
 8    5                                                                               11
 1    0.0        0.0         0.0        0.0
 2   -3.33333   48.6        30.75       0.0
 3   -6.66667   48.6        30.75       0.0                                           12
 4  -10.00000   48.6        30.75       0.0
 5  -15.00000   48.6        30.75       0.0
 6  -20.00000   48.6        30.75       0.0
 0                                                                                    13
16    1                                                                               15
.18074      .09400     .06400     .04460     .02800     .01955    -.00122    -.01341
-.02561    -.03782    -.05005    -.06000    -.06600    -.06719    -.06719    -.06719    16
 1    0.0        0.0        3.33333    1.652      -8.24583                            17
 2    2                                                                               18
 1    2.7834
 2    3.6094                                                                          19
 3    4.4354
60    1                                                                               20
1.7406     .7502      .3536      .06686     0.0        0.0        0.0        0.0
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0       21
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
0.0        0.0        0.0        0.0        0.0        0.0        0.0        0.0
-.06686    -.3536     -.7502     -1.7406
5.56833    0.31667    -7.12833   4.75207    0.0                                       22
```

(a) Page 1.

Figure 19.- Input data for sample trajectory calculation number 2.

							Item No.
39							23
2.0000E-03	5.9937E-03	1.2879E-02	2.2899E-02	3.6119E-02	5.2485E-02		
7.1853E-02	9.4006E-02	1.1866E-01	1.4548E-01	1.7406E-01	2.0404E-01		
2.3488E-01	2.6613E-01	2.9740E-01	3.2867E-01	3.5995E-01	3.9122E-01		
4.2249E-01	4.5377E-01	4.8504E-01	5.1631E-01	5.4759E-01	5.7886E-01		24
6.1013E-01	6.4141E-01	6.7268E-01	7.0395E-01	7.3523E-01	7.6650E-01		
7.9777E-01	8.2905E-01	8.6032E-01	8.9159E-01	9.2287E-01	9.5278E-01		
9.7867E-01	9.9869E-01	1.0125E+00					
-5.6644E-07	2.0447E-05	5.2143E-05	6.6002E-05	8.0062E-05	8.8621E-05		
9.2691E-05	9.0897E-05	8.2019E-05	7.5763E-05	1.7835E-05	1.2050E-04		
-1.1040E-04	5.3828E-05	-5.1306E-05	4.5747E-05	-4.8280E-05	4.6454E-05		
-4.7069E-05	4.6662E-05	-4.7357E-05	4.7119E-05	-4.7125E-05	4.7348E-05		25
-4.6877E-05	4.7641E-05	-4.6504E-05	4.8151E-05	-4.5776E-05	4.9387E-05		
-4.4521E-05	5.8037E-05	-7.4667E-05	2.8150E-04	-2.9126E-04	-3.0856E-04		
-2.1453E-04	-7.9127E-05	-4.6523E-05					
10 5	7.38333	0.44667	-1.0275	-6.66667	1.98612	0.0	
20 2	10.625	0.625	-4.6	0.0	6.52167	0.0	
21 2	10.625	0.625	-3.6172	-0.86667	4.96333	0.0	26
22 2	10.625	0.625	-3.6172	0.86667	4.96333	0.0	
30 5	7.38333	0.44667	-1.0275	6.66667	1.98612	0.0	
2							27
5 44							28
2.0000E-03	2.8692E-03	4.1068E-03	5.8625E-03	8.3399E-03	1.1810E-02		
1.6619E-02	2.3192E-02	3.2007E-02	4.3538E-02	5.8146E-02	7.5981E-02		
9.7189E-02	1.2159E-01	1.4862E-01	1.7742E-01	2.0779E-01	2.3980E-01		
2.7354E-01	3.0909E-01	3.4653E-01	3.8580E-01	4.2644E-01	4.6791E-01		
5.0958E-01	5.5081E-01	5.9097E-01	6.2948E-01	6.6584E-01	6.9965E-01		29
7.3065E-01	7.5881E-01	7.8492E-01	8.0970E-01	8.3372E-01	8.5746E-01		
8.8119E-01	9.0493E-01	9.2867E-01	9.5241E-01	9.7614E-01	9.9988E-01		
1.0236E+00	1.0435E+00						
3.8950E-06	-2.9405E-06	1.8989E-06	5.6064E-07	2.6288E-06	4.7915E-06		
9.7339E-06	1.8419E-05	3.2418E-05	5.3617E-05	5.6472E-05	9.3568E-05		
8.9716E-05	9.5866E-05	-5.8868E-05	1.3457E-04	-2.0499E-05	1.2904E-04		
1.0512E-05	1.3466E-04	9.0154E-05	-2.6121E-05	1.2754E-04	-1.0693E-04		
6.5856E-05	-1.7406E-04	3.1092E-05	-2.3365E-04	4.9612E-05	-2.8651E-04		30
8.2015E-05	-2.0799E-04	1.6871E-04	-2.1783E-04	2.2493E-04	-2.1059E-04		
2.1369E-04	-2.0999E-04	2.1388E-04	-2.0582E-04	1.9470E-04	2.2662E-05		
-4.1387E-04	1.8464E-05						
2 51							28
2.0000E-03	2.6473E-03	3.5132E-03	4.6705E-03	6.2149E-03	8.2721E-03		
1.1006E-02	1.4626E-02	1.9400E-02	2.5661E-02	3.3810E-02	4.4316E-02		
5.7699E-02	7.4485E-02	9.5145E-02	1.1999E-01	1.4904E-01	1.8194E-01		
2.1781E-01	2.5531E-01	2.9305E-01	3.3079E-01	3.6852E-01	4.0626E-01		
4.4400E-01	4.8173E-01	5.1947E-01	5.5721E-01	5.9494E-01	6.3268E-01		29
6.7042E-01	7.0815E-01	7.4589E-01	7.8363E-01	8.2136E-01	8.5910E-01		
8.9684E-01	9.3457E-01	9.7231E-01	1.0100E+00	1.0477E+00	1.0840E+00		
1.1171E+00	1.1459E+00	1.1697E+00	1.1884E+00	1.2025E+00	1.2127E+00		
1.2200E+00	1.2250E+00	1.2284E+00					
4.8513E-06	-4.3215E-06	2.4426E-06	-7.1054E-07	1.2638E-06	1.0935E-06		
2.5749E-06	4.3291E-06	7.8030E-06	1.3510E-05	2.3018E-05	3.7947E-05		
5.9954E-05	8.9502E-05	1.2214E-04	1.5482E-04	1.8820E-04	2.0261E-04		
-5.0476E-05	-1.1398E-04	1.1594E-04	-1.2468E-04	1.2050E-04	-1.2326E-04		
1.2144E-04	-1.2266E-04	1.2185E-04	-1.2235E-04	1.2211E-04	-1.2213E-04		30
1.2233E-04	-1.2188E-04	1.2263E-04	-1.2149E-04	1.2318E-04	-1.2063E-04		
1.2450E-04	-1.1674E-04	1.1695E-04	1.1480E-05	-1.1924E-04	-1.7271E-04		
-1.7495E-04	-1.3912E-04	-9.3587E-05	-5.4285E-05	-2.9966E-05	-1.2530E-05		
-1.0227E-05	4.6640E-06	-1.1715E-05					
20 20	20 0	2 0	0 1				31
15.53	8.0	80.0	80.0	0.0	0.0	0.0	32
-5.3125	0.0	0.0	0.0				33
0.2353	1.1						34
-0.4413	-1.0	0.4706	0.1947			1.0	35
0.058B2							
0.2	0.0						36
10.0	0.0						39
0.05	0.0	0.6					40

(b) Page 2.

Figure 19.- Concluded.

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                    SIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM

SAMPLE TRAJECTORY CALCULATION NUMBER 1
     AIRCRAFT AND STORES ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
          PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
     MODELS SCALED UP BY A FACTOR OF 20 TO APPROXIMATE A FULL SCALE AIRCRAFT
     THERE IS A FINNED OGIVE-CYLINDER STORE ON A PYLON AT THE 1/3 SEMISPAN
          LOCATION OF THE LEFT WING PANEL
     THERE ARE ALSO THREE SMALL FINLESS BOATTAILED STORES GROUPED AS A TER
          CLUSTER UNDER THE FUSELAGE
     THE STORE UNDER THE WING IS EJECTED WITH THE TRAJECTORY STARTING ONE
          RADIUS BELOW THE CARRIAGE POSITION
     IT IS A FREE-FLIGHT TRAJECTORY, NOT A CAPTIVE STORE TRAJECTORY
     ROLLING MOMENT IS CALCULATED
     DAMPING IS INCLUDED


AIRCRAFT FLIGHT CONDITIONS
     ANGLE OF ATTACK =  4.00 DEGREES
     FLIGHT PATH ANGLE =  0.00 DEGREES
     MACH NUMBER =  .40
     FREE STREAM MASS DENSITY =  .0020482 SLUGS PER CUBIC FOOT
     FREE STREAM VELOCITY =  440.70 FEET PER SECOND


FUSELAGE INPUT DATA
     FUSELAGE LENGTH =  60.65000 FEET
     MAXIMUM RADIUS =  2.78340 FEET


                              INCOMPRESSIBLE SOURCE DISTRIBUTION

     X/L   2.00000E-03 2.53000E-03 3.20060E-03 4.04870E-03 5.12060E-03 6.47450E-03 8.18310E-03 1.03370E-02
     Q*(K) 6.03530E-06-5.47820E-06 3.53980E-06-2.17850E-06 1.61620E-06-6.69620E-07 1.04450E-06 3.10400E-07

     X/L   1.30480E-02 1.64560E-02 2.07290E-02 2.60720E-02 3.27300E-02 4.09930E-02 5.11920E-02 6.36970E-02
     Q*(K) 1.37370E-06 1.60040E-06 2.87800E-06 4.22660E-06 6.64360E-06 9.93870E-06 1.48130E-05 2.14030E-05

     X/L   7.89070E-02 9.72240E-02 1.19020E-01 1.44580E-01 1.74060E-01 2.07370E-01 2.44150E-01 2.83720E-01
     Q*(K) 3.00630E-05 4.05820E-05 5.20730E-05 6.24870E-05 6.87670E-05 6.29460E-05 7.32610E-05 4.50690E-06

     X/L   3.25080E-01 3.66960E-01 4.08850E-01 4.50730E-01 4.92620E-01 5.34500E-01 5.76390E-01 6.18270E-01
     Q*(K)-7.68290E-07-1.27660E-05 9.99140E-06-1.15010E-05 1.07170E-05-1.10600E-05 1.10630E-05-1.07030E-05

     X/L   6.60160E-01 7.02040E-01 7.43930E-01 7.85810E-01 8.27450E-01 8.68050E-01 9.06870E-01 9.43260E-01
     Q*(K) 1.15550E-05-9.89930E-06 1.64960E-05-1.32980E-05-3.14260E-05-4.55380E-05-5.38350E-05-5.64920E-05

     X/L   9.76730E-01 1.00700E+00 1.03380E+00 1.05730E+00 1.07760E+00 1.09480E+00 1.10940E+00 1.12150E+00
     Q*(K)-5.39670E-05-4.82290E-05-4.03720E-05-3.24970E-05-2.47050E-05-1.86520E-05-1.30210E-05-9.74060E-06

     X/L   1.13160E+00 1.13990E+00 1.14670E+00 1.15220E+00 1.15670E+00 1.16030E+00 1.16320E+00 1.16560E+00
     Q*(K)-5.94580E-06-5.11050E-06-1.93940E-06-3.36030E-06 7.12840E-07-3.64580E-05 3.49100E-06-6.00770E-06

     X/L   1.16750E+00 1.16900E+00
     Q*(K) 8.06400E-06-9.41390E-06
```

(a) Page 1.

Figure 20.- Trajectory program output for sample case 1.

WING INPUT DATA

LOCATION OF WING ROOT CHORD LEADING EDGE RELATIVE TO FUSELAGE NOSE
XF = -22.46600 FEET
ZF = 0.00000 FEET
INCIDENCE ANGLE OF WING ROOT CHORD RELATIVE TO FUSELAGE AXIS
IW = 0.00 DEGREES
LENGTH OF WING ROOT CHORD
CRW = 15.41200 FEET
WING SEMISPAN
SSPAN = 20.00000 FEET

40 VORTICES ARE TO BE LAID OUT ON EACH WING PANEL
5 CHORDWISE ROWS WITH 8 IN EACH ROW

SPANWISE LOCATIONS OF TRAILING VORTEX LEGS AND SWEEP ANGLES AND DIHEDRAL ANGLE OF WING SECTION TO THE RIGHT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES	DIHEDRAL DEGREES
1	0.00000	0.00000	0.00000	0.00000
2	-3.33333	48.60000	30.75000	0.00000
3	-6.66667	48.60000	30.75000	0.00000
4	-10.00000	48.60000	30.75000	0.00000
5	-15.00000	48.60000	30.75000	0.00000
6	-20.00000	48.60000	30.75000	0.00000

80 THICKNESS PANELS ARE TO BE LAID OUT ON EACH WING PANEL
5 CHORDWISE ROWS WITH 16 IN EACH ROW
THE CHORDWISE ROWS COINCIDE WITH THOSE USED IN THE VORTEX LATTICE

(b) Page 2.

Figure 20.- Continued.

```
PYLON INPUT DATA

    LEADING EDGE OF PYLON ROOT CHORD IS AT X=  -3.04600 FEET (MEASURED FROM LOCAL WING LEADING EDGE)
    SPANWISE LOCATION IS Y=  -6.66667 FEET
    ROOTCHORD =   3.33333 FEET
    HEIGHT =   1.65200 FEET
    LEADING EDGE SWEEP ANGLE =   0.00000 DEGREES
    TRAILING EDGE SWEEP ANGLE =   0.00000 DEGREES


      4 VORTICES ARE TO BE LAID OUT ON THE PYLON
          2 CHORDWISE ROWS WITH  2 IN EACH ROW

    SPANWISE LOCATIONS OF TRAILING VORTEX LEGS

         K          Z
                  FEET
         1       0.00000
         2        .82600
         3       1.65200


    120 THICKNESS PANELS ARE TO BE LAID OUT ON THE PYLON
          2 CHORDWISE ROWS WITH 60 IN EACH ROW
        THE CHORDWISE ROWS COINCIDE WITH THOSE USED
        IN THE VORTEX LATTICE
```

(c) Page 3.

Figure 20.- Continued.

VORTEX LATTICE CONTROL POINT COORDINATES AND
INPUT TWIST AND CAMBER DISTRIBUTION
AT THESE POINTS
(WING COORDINATE SYSTEM)

WING CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	SLOPE
1	1	-3.25106	-1.66667	0.00000	0.00000
1	2	-5.06520	-1.66667	0.00000	0.00000
1	3	-6.87934	-1.66667	0.00000	0.00000
1	4	-8.69348	-1.66667	0.00000	0.00000
1	5	-10.50761	-1.66667	0.00000	0.00000
1	6	-12.32175	-1.66667	0.00000	0.00000
1	7	-14.13589	-1.66667	0.00000	0.00000
1	8	-15.95003	-1.66667	0.00000	0.00000
2	1	-6.86345	-5.00000	0.00000	0.00000
2	2	-8.45286	-5.00000	0.00000	0.00000
2	3	-10.04227	-5.00000	0.00000	0.00000
2	4	-11.63168	-5.00000	0.00000	0.00000
2	5	-13.22110	-5.00000	0.00000	0.00000
2	6	-14.81051	-5.00000	0.00000	0.00000
2	7	-16.39992	-5.00000	0.00000	0.00000
2	8	-17.98933	-5.00000	0.00000	0.00000
3	1	-10.47583	-8.33333	0.00000	0.00000
3	2	-11.84052	-8.33333	0.00000	0.00000
3	3	-13.20520	-8.33333	0.00000	0.00000
3	4	-14.56989	-8.33333	0.00000	0.00000
3	5	-15.93458	-8.33333	0.00000	0.00000
3	6	-17.29927	-8.33333	0.00000	0.00000
3	7	-18.66395	-8.33333	0.00000	0.00000
3	8	-20.02864	-8.33333	0.00000	0.00000
4	1	-14.99130	-12.50000	0.00000	0.00000
4	2	-16.07508	-12.50000	0.00000	0.00000
4	3	-17.15887	-12.50000	0.00000	0.00000
4	4	-18.24265	-12.50000	0.00000	0.00000
4	5	-19.32643	-12.50000	0.00000	0.00000
4	6	-20.41021	-12.50000	0.00000	0.00000
4	7	-21.49399	-12.50000	0.00000	0.00000
4	8	-22.57777	-12.50000	0.00000	0.00000
5	1	-20.40987	-17.50000	0.00000	0.00000
5	2	-21.15657	-17.50000	0.00000	0.00000
5	3	-21.90326	-17.50000	0.00000	0.00000
5	4	-22.64996	-17.50000	0.00000	0.00000
5	5	-23.39665	-17.50000	0.00000	0.00000
5	6	-24.14334	-17.50000	0.00000	0.00000
5	7	-24.89004	-17.50000	0.00000	0.00000
5	8	-25.63673	-17.50000	0.00000	0.00000

PYLON CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT
1	1	-11.85785	-6.66667	.41300
1	2	-13.52452	-6.66667	.41300
2	1	-11.85785	-6.66667	1.23900
2	2	-13.52452	-6.66667	1.23900

(d) Page 4.

Figure 20.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS DISTRIBUTION. FOR EACH CHORDWISE ROW THE FIRST VALUE IS FOR THE PANEL NEAREST THE LEADING EDGE

WING THICKNESS DATA

ROW	SLOPES							
1	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
2	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
3	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
4	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
5	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719

PYLON THICKNESS DATA

ROW	SLOPES							
1	1.74060	.75020	.35360	.06686	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	-.06686	-.35360	-.75020	-1.74060				
2	1.74060	.75020	.35360	.06686	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	-.06686	-.35360	-.75020	-1.74060				

(e) Page 5.

Figure 20.- Continued.

STORE INPUT DATA

STORE NO	SHAPE NO	LENGTH FT	MAXIMUM RADIUS FT	STORE LOCATION RELATIVE TO LOCAL WING CHORD LEADING EDGE X, FT	Y, FT	Z, FT	INCIDENCE ANGLE DEG
10	2	10.62500	.62500	.59333	-6.66667	2.90200	0.00000
20	5	7.38333	.44667	-6.22083	0.00000	5.71666	0.00000
21	5	7.38333	.44667	-5.37033	-.75000	4.83333	0.00000
22	5	7.38333	.44667	-5.37033	.75000	4.83333	0.00000

SOURCE DISTRIBUTION FOR SHAPE NO 2

INCOMPRESSIBLE SOURCE DISTRIBUTION

X/L	2.00000E-03	2.64730E-03	3.51320E-03	4.67050E-03	6.21490E-03	8.27210E-03	1.10060E-02	1.46260E-02
Q*(K)	4.85130E-06	-4.32150E-06	2.44260E-06	-7.10540E-07	1.26380E-06	1.09350E-05	2.57490E-06	4.32910E-06
X/L	1.94000E-02	2.56610E-02	3.38100E-02	4.43160E-02	5.76990E-02	7.44850E-02	9.51450E-02	1.19990E-01
Q*(K)	7.80300E-06	1.35100E-05	2.30180E-05	3.79470E-05	5.99540E-05	8.95020E-05	1.22140E-04	1.54820E-04
X/L	1.49040E-01	1.81940E-01	2.17810E-01	2.55310E-01	2.93050E-01	3.30790E-01	3.68520E-01	4.06260E-01
Q*(K)	1.28200E-04	2.02610E-04	-5.04760E-05	-1.13980E-04	1.15940E-04	-1.24680E-04	1.20500E-04	-1.23260E-04
X/L	4.44000E-01	4.81730E-01	5.19470E-01	5.57210E-01	5.94940E-01	6.32680E-01	6.70420E-01	7.08150E-01
Q*(K)	1.21440E-04	-1.22660E-04	1.21850E-04	-1.22350E-04	1.22110E-04	-1.22130E-04	1.22330E-04	-1.21880E-04
X/L	7.45890E-01	7.83630E-01	8.21360E-01	8.59100E-01	8.96840E-01	9.34570E-01	9.72310E-01	1.01000E+00
Q*(K)	1.22630E-04	-1.21490E-04	1.23180E-04	-1.20630E-04	1.24500E-04	-1.16740E-04	1.16950E-04	1.14800E-05
X/L	1.04770E+00	1.08400E+00	1.11710E+00	1.14590E+00	1.16970E+00	1.18840E+00	1.20250E+00	1.21270E+00
Q*(K)	-1.19240E-04	-1.72710E-04	-1.74950E-04	-1.39120E-04	-9.35870E-05	-5.42850E-05	-2.99660E-05	-1.25300E-05
X/L	1.22000E+00	1.22500E+00	1.22840E+00					
Q*(K)	-1.02270E-05	4.66400E-06	-1.17130E-05					

SOURCE DISTRIBUTION FOR SHAPE NO 5

INCOMPRESSIBLE SOURCE DISTRIBUTION

X/L	2.00000E-03	2.86920E-03	4.10680E-03	5.86250E-03	8.33990E-03	1.18100E-02	1.66190E-02	2.31920E-02
Q*(K)	3.89500E-06	-2.94050E-06	1.89890E-06	5.60640E-07	2.62880E-06	4.79150E-06	9.73390E-06	1.84190E-05
X/L	3.20070E-02	4.35380E-02	5.81460E-02	7.59810E-02	9.71690E-02	1.21590E-01	1.48620E-01	1.77420E-01
Q*(K)	3.24180E-05	5.36170E-05	5.64720E-05	9.35680E-05	8.97160E-05	9.58660E-05	-5.88680E-05	1.34570E-04
X/L	2.07790E-01	2.39800E-01	2.73540E-01	3.09090E-01	3.46530E-01	3.85800E-01	4.26440E-01	4.67910E-01
Q*(K)	-2.04990E-05	1.29040E-04	1.05120E-05	1.34660E-04	9.01540E-05	-2.61210E-05	1.27540E-04	-1.06930E-04
X/L	5.09580E-01	5.50810E-01	5.90970E-01	6.29480E-01	6.65840E-01	6.99650E-01	7.30650E-01	7.58810E-01
Q*(K)	6.58560E-05	-1.74060E-04	3.10920E-05	-2.33650E-04	4.96120E-05	-2.86510E-04	8.20150E-05	-2.07990E-04
X/L	7.84920E-01	8.09700E-01	8.33720E-01	8.57460E-01	8.81190E-01	9.04930E-01	9.28670E-01	9.52410E-01
Q*(K)	1.68710E-04	-2.17830E-04	2.24930E-04	-2.10590E-04	2.13690E-04	-2.09990E-04	2.13880E-04	-2.05820E-04
X/L	9.76140E-01	9.99880E-01	1.02360E+00	1.04350E+00				
Q*(K)	1.94700E-04	2.26620E-05	-4.13870E-04	1.84640E-05				

(f) Page 6.

Figure 20.- Continued.

VORTEX LATTICE CONTROL POINT COORDINATES
INTERFERENCE VELOCITIES INDUCED AT THESE POINTS
CALCULATED VORTEX STRENGTHS
(WING COORDINATE SYSTEM)

WING CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	U/VINF	V/VINF	W/VINF	GAMMA/VINF
1	1	-3.25106	-1.66667	0.00000	.00222	.00059	-.00259	.46855
1	2	-5.06520	-1.66667	0.00000	.00154	.00103	-.00418	.24799
1	3	-6.87934	-1.66667	0.00000	-.00120	.00182	-.00509	.18793
1	4	-8.69348	-1.66667	0.00000	-.00499	.00274	-.00339	.14525
1	5	-10.50761	-1.66667	0.00000	-.00674	.00290	.00024	.11146
1	6	-12.32175	-1.66667	0.00000	-.00557	.00162	.00286	.08888
1	7	-14.13589	-1.66667	0.00000	-.00314	-.00016	.00352	.07134
1	8	-15.95003	-1.66667	0.00000	-.00130	-.00145	.00314	.04854
2	1	-6.86345	-5.00000	0.00000	.00285	.00328	-.00820	.53281
2	2	-8.45286	-5.00000	0.00000	-.00101	.00620	-.00568	.25502
2	3	-10.04227	-5.00000	0.00000	-.00506	.01178	-.00823	.17273
2	4	-11.63168	-5.00000	0.00000	-.01595	.00704	-.00301	.12221
2	5	-13.22110	-5.00000	0.00000	-.01336	-.00619	.00410	.08794
2	6	-14.81051	-5.00000	0.00000	-.00135	-.00676	.00540	.07498
2	7	-16.39992	-5.00000	0.00000	-.00225	-.00277	.00513	.05885
2	8	-17.98933	-5.00000	0.00000	-.00209	-.00383	.00787	.03257
3	1	-10.47583	-8.33333	0.00000	-.00710	-.01254	-.00789	.51205
3	2	-11.84052	-8.33333	0.00000	-.01548	-.00393	-.00271	.22712
3	3	-13.20520	-8.33333	0.00000	-.01315	.00785	.00314	.15060
3	4	-14.56989	-8.33333	0.00000	-.00230	.00977	.00486	.11711
3	5	-15.93458	-8.33333	0.00000	-.00193	.00477	.00413	.09482
3	6	-17.29927	-8.33333	0.00000	-.00314	.00448	.00608	.07045
3	7	-18.66395	-8.33333	0.00000	-.00082	.00536	.00838	.05096
3	8	-20.02864	-8.33333	0.00000	.00294	.00454	.00729	.03584
4	1	-14.99130	-12.50000	0.00000	-.00241	.00154	.00852	.44449
4	2	-16.07508	-12.50000	0.00000	-.00195	.00202	.00877	.21138
4	3	-17.15887	-12.50000	0.00000	-.00143	.00236	.00898	.14839
4	4	-18.24265	-12.50000	0.00000	-.00084	.00255	.00812	.11350
4	5	-19.32643	-12.50000	0.00000	-.00023	.00254	.00815	.08896
4	6	-20.41021	-12.50000	0.00000	.00031	.00233	.00807	.06919
4	7	-21.49399	-12.50000	0.00000	.00067	.00199	.00792	.05119
4	8	-22.57777	-12.50000	0.00000	.00086	.00161	.00875	.03196
5	1	-20.40987	-17.50000	0.00000	-.00018	.00079	.00820	.34461
5	2	-21.15657	-17.50000	0.00000	-.00009	.00078	.00820	.16329
5	3	-21.90326	-17.50000	0.00000	-.00001	.00075	.00819	.11374
5	4	-22.64996	-17.50000	0.00000	.00005	.00071	.00818	.08573
5	5	-23.39665	-17.50000	0.00000	.00011	.00066	.00817	.06557
5	6	-24.14334	-17.50000	0.00000	.00015	.00061	.00816	.04928
5	7	-24.89004	-17.50000	0.00000	.00018	.00056	.00814	.03503
5	8	-25.63673	-17.50000	0.00000	.00020	.00051	.00813	.02101

PYLON CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	V/VINF	GAMMA/VINF
1	1	-11.85785	-6.66667	.41300	.04004	.03896
1	2	-13.52452	-6.66667	.41300	.04008	-.00785
2	1	-11.85785	-6.66667	1.23900	.02832	.03588
2	2	-13.52452	-6.66667	1.23900	.02980	-.01295

(g) Page 7.

Figure 20.- Continued.

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STORE NUMBER   10 IS THE STORE EJECTED

    ADDITIONAL INPUT FOR THIS STORE
         STORE MASS =  15.53000 SLUGS
         MOMENTS AND PRODUCTS OF INERTIA, SLUG - SQ FT
            IXX =   8.00000
            IYY =  80.00000
            IZZ =  80.00000
            IYZ =  -0.00000
            IXZ =  -0.00000
            IXY =  -0.00000
         STORE MOMENT CENTER IS -5.31250 FEET BEHIND NOSE
         STORE CENTER OF GRAVITY OFFSET FROM MOMENT CENTER, FEET
            XBAR = -0.00000
            YBAR = -0.00000
            ZBAR = -0.00000
         POLYNOMIALS SPECIFYING COMPRESSIBLE STORE SHAPE
            X/L OF END OF EACH SECTION
               SECTION      X/L
                  1        .23530
                  2       1.10000
            COEFFICIENTS OF POLYNOMIALS DESCRIBING EACH SECTION
               SECTION      C1         C2         C3         C4         C5         C6         C7
                  1       -.44130  -1.00000     .47060     .19470  -0.00000  -0.00000   1.00000
                  2        .05882  -0.00000  -0.00000  -0.00000  -0.00000  -0.00000  -0.00000
         SEPARATION ASSUMED  10.62500 FEET FROM NOSE
         AXIAL-FORCE COEFFICIENT IS     .40000
         CROSSFLOW-DRAG COEFFICIENT IS   0.00000

         THIS STORE HAS A CRUCIFORM EMPENNAGE
         THE EMPENNAGE FORCES ACT -9.37600 FEET BEHIND NOSE
         THE AVERAGE BODY RADIUS IN THE EMPENNAGE REGION IS    .62500 FEET
         THE TAIL FIN SEMISPAN MEASURED FROM THE BODY AXIS IS  1.45833 FEET
         THE FINS ARE INITIALLY ROLLED 45.00 DEGREES FROM THE VERTICAL AND HORIZONTAL
         THE FIN LIFT-CURVE SLOPE IS  3.22000 PER RADIAN
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(h) Page 8.

Figure 20.- Continued.

TIME = 0.00000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	.00331	.05182	-.11664	.05864	
SLENDER BODY	.15013	-.02781	.38065	-.20897	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	.48463	-.06976	-1.57544	.22676	.00341
TOTAL	.63807	-.04574	-1.31144	.07643	.00341

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	.04912	-.02518	.97263	-.03989	.08130
.79688	.07500	.07788	-.04730	.97254	-.04015	.07594
1.32813	.12500	.05337	-.03917	.97312	-.03939	.07028
1.85938	.17500	.00853	-.01347	.97434	-.03769	.06449
2.39063	.22500	-.03650	.01586	.97630	-.03523	.05863
2.92188	.27500	-.04169	.02301	.97962	-.03229	.05277
3.45313	.32500	-.02090	.02327	.98550	-.02919	.04817
3.98438	.37500	.01616	.02225	.99307	-.02615	.04789
4.51563	.42500	.03565	.02107	.99864	-.02328	.05174
5.04688	.47500	.03981	.01968	1.00165	-.02056	.05684
5.57813	.52500	.04357	.01757	1.00320	-.01807	.06234
6.10938	.57500	.04673	.01461	1.00323	-.01592	.06843
6.64063	.62500	.03409	.01117	1.00057	-.01421	.07422
7.17188	.67500	.00422	.00774	.99577	-.01295	.07878
7.70313	.72500	-.00925	.00451	.99242	-.01215	.07602
8.23438	.77500	-.00617	.00162	.99114	-.01174	.07488
8.76563	.82500	-.00174	-.00083	.99057	-.01170	.07440
9.29688	.87500	-.00009	-.00273	.98997	-.01195	.07432
9.82813	.92500	-.00086	-.00398	.98918	-.01240	.07429
10.35937	.97500	-.00313	-.00450	.98825	-.01298	.07405

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-29.43452	-6.66667	2.90200	.00000	0.00000	0.00000
XMOM	-34.74702	-6.66667	2.90200	0.00000	0.00000	0.00000
BASE	-40.05952	-6.66667	2.90200	.00000	0.00000	0.00000

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
0.00000	0.00000	10.00000	-8.55424	-.72155	22.03029

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
0.00000	0.00000	0.00000	.13068	-5.01997	.29257

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

(i) Page 9.

Figure 20.- Continued.

TIME = .33000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	-.02861	.01105	.00637	.00578	
SLENDER BODY	-.07613	.00232	-.15164	-.02370	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	-.23144	.00735	.75237	-.02388	-.00005
TOTAL	-.33618	.02071	.60710	-.04180	-.00005

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	-.01387	-.00285	.99323	-.00456	-.02155
.79688	.07500	-.02973	-.00504	.99346	-.00448	-.02272
1.32813	.12500	-.03254	-.00367	.99372	-.00428	-.02387
1.85938	.17500	-.02529	-.00044	.99398	-.00397	-.02496
2.39063	.22500	-.01104	.00296	.99422	-.00355	-.02601
2.92188	.27500	-.00717	.00389	.99442	-.00306	-.02700
3.45313	.32500	-.00664	.00410	.99459	-.00252	-.02792
3.98438	.37500	-.00609	.00410	.99468	-.00197	-.02876
4.51563	.42500	-.00556	.00393	.99472	-.00144	-.02953
5.04688	.47500	-.00511	.00362	.99469	-.00094	-.03024
5.57813	.52500	-.00478	.00322	.99459	-.00048	-.03090
6.10938	.57500	-.00460	.00276	.99444	-.00008	-.03152
6.64063	.62500	-.00459	.00229	.99423	.00025	-.03212
7.17188	.67500	-.00473	.00183	.99398	.00052	-.03274
7.70313	.72500	-.00499	.00140	.99371	.00074	-.03338
8.23438	.77500	-.00533	.00103	.99344	.00090	-.03407
8.76563	.82500	-.00571	.00074	.99318	.00102	-.03480
9.29688	.87500	-.00609	.00052	.99296	.00110	-.03558
9.82813	.92500	-.00647	.00039	.99278	.00116	-.03642
10.35937	.97500	-.00684	.00036	.99264	.00121	-.03730

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-29.64944	-6.64122	7.75488	-.21492	.02545	4.85288
XMOM	-34.91757	-6.69052	7.07147	-.17055	-.02385	4.16947
BASE	-40.18570	-6.73982	6.38807	-.12617	-.07315	3.48607

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
-.68143	-.09959	18.62260	-.63350	.36865	36.86115

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
.00515	-.45983	.03813	-.00173	2.32617	-.15804

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
.53620	-7.39106	.04346	.03810	-.45986	.00025

(j) Page 10.

Figure 20.- Continued.

TIME = .60000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	.00684	-.00207	-.00138	.00035	
SLENDER BODY	-.01953	.00688	-.00988	.00342	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	-.06458	.02273	.20995	-.07390	-.00003
TOTAL	-.07728	.02754	.11870	-.04314	-.00003

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	-.00826	.00282	.99685	.00456	-.01333
.79688	.07500	-.01517	.00512	.99683	.00446	-.01312
1.32813	.12500	-.01378	.00462	.99681	.00438	-.01291
1.85938	.17500	-.00785	.00263	.99678	.00430	-.01270
2.39063	.22500	-.00003	.00004	.99676	.00423	-.01249
2.92188	.27500	.00163	-.00048	.99673	.00416	-.01227
3.45313	.32500	.00163	-.00045	.99669	.00410	-.01206
3.98438	.37500	.00162	-.00043	.99665	.00404	-.01184
4.51563	.42500	.00159	-.00041	.99661	.00398	-.01163
5.04688	.47500	.00156	-.00040	.99656	.00393	-.01142
5.57813	.52500	.00152	-.00040	.99651	.00388	-.01121
6.10938	.57500	.00147	-.00040	.99646	.00382	-.01101
6.64063	.62500	.00143	-.00040	.99641	.00377	-.01082
7.17188	.67500	.00137	-.00041	.99636	.00372	-.01064
7.70313	.72500	.00132	-.00041	.99632	.00366	-.01046
8.23438	.77500	.00128	-.00041	.99628	.00361	-.01028
8.76563	.82500	.00123	-.00041	.99626	.00355	-.01012
9.29688	.87500	.00120	-.00040	.99624	.00350	-.00996
9.82813	.92500	.00118	-.00038	.99623	.00345	-.00980
10.35937	.97500	.00116	-.00036	.99623	.00340	-.00964

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-30.13832	-6.64507	15.10681	-.70379	.02160	12.20481
XMOM	-35.39700	-6.69036	14.35391	-.64998	-.02369	11.45191
BASE	-40.65568	-6.73564	13.60101	-.59616	-.06897	10.69901

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM

RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
-3.39481	.10764	29.62998	-16.44409	.48567	31.51233

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
.00478	.26324	-.04360	-.00125	.45186	-.16543

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES

ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
.49334	-8.14753	.13647	-.04341	.26334	.01093

(k) Page 11.

Figure 20.- Concluded.

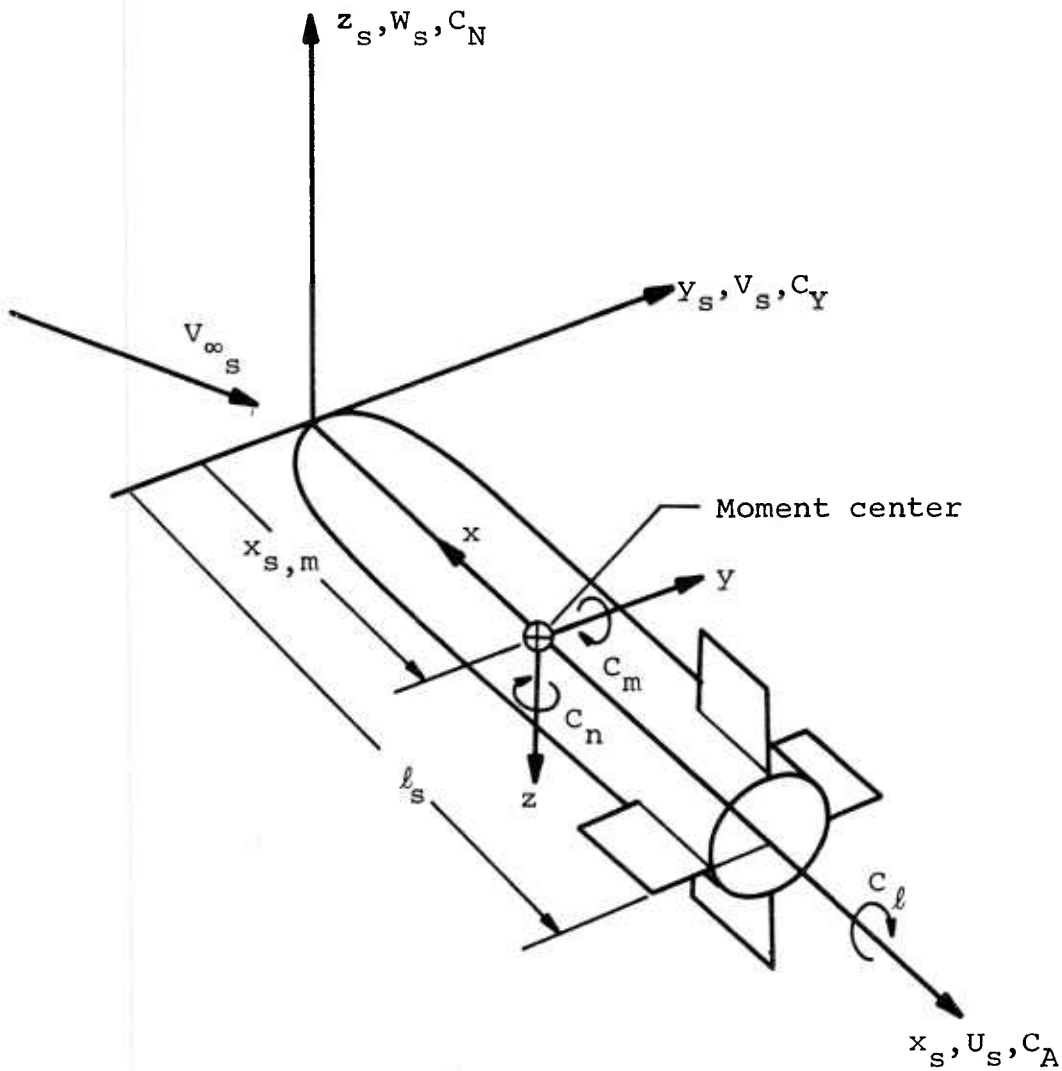

Figure 21.- Coordinate systems fixed in separated store and used in force and moment calculation.

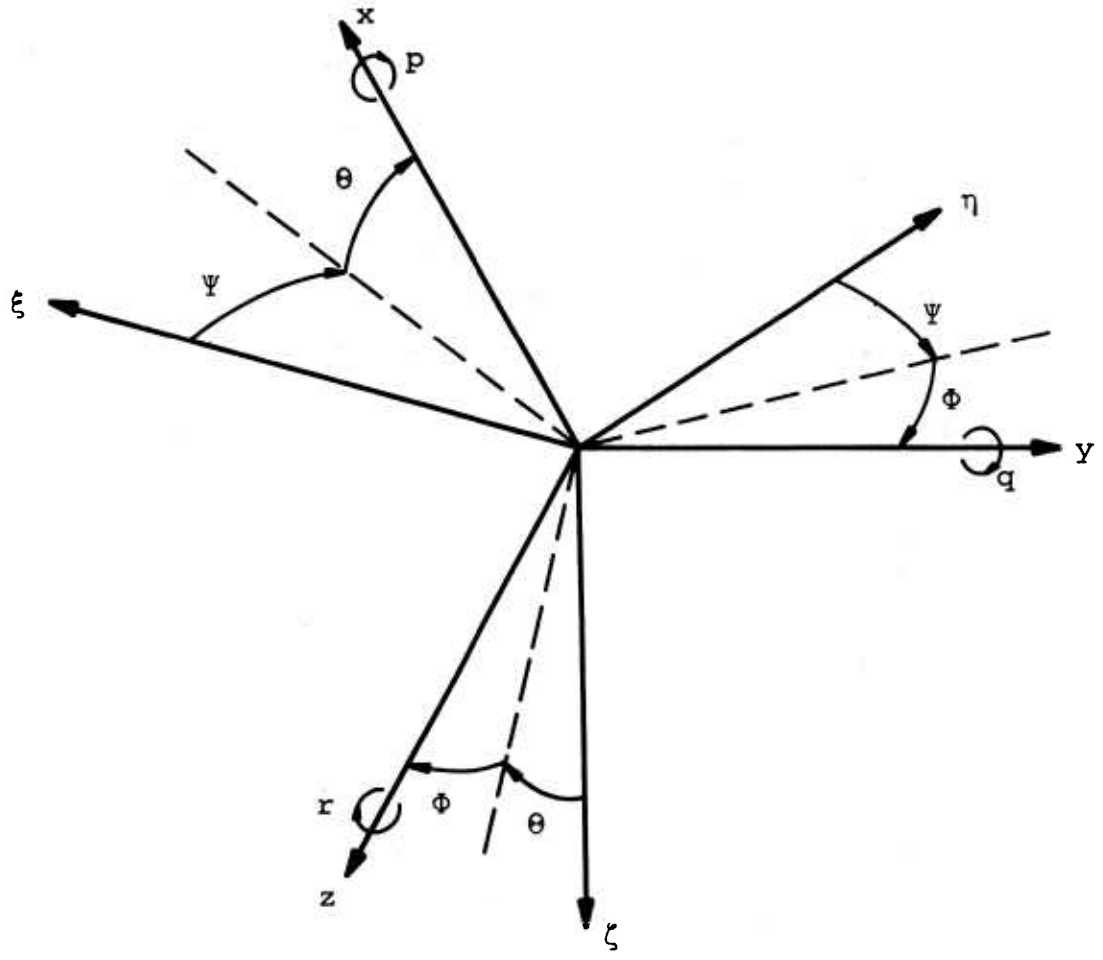

Figure 22.- Coordinate systems used in trajectory calculation.

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                SIX-DEGREE-OF-FREEDOM TRAJECTORY PROGRAM

SAMPLE TRAJECTORY CALCULATION NUMBER 2
     AIRCRAFT AND STORES ARE SCALED UP VERSIONS OF MODELS USED IN EXPERIMENTAL
          PROGRAM CONDUCTED IN CONJUNCTION WITH THIS WORK
     MODELS SCALED UP BY A FACTOR OF 20 TO APPROXIMATE A FULL SCALE AIRCRAFT
     THERE IS A SMALL FINLESS BOATTAILED STORE AT THE 1/3 SEMISPAN LOCATION
          OF BOTH WING PANELS
     THERE ALSO ARE THREE FINLESS OGIVE-CYLINDER STORES GROUPED ON A
          TER-RACK/PYLON UNDER THE FUSELAGE
     THE BOTTOM STORE OF THE TER GROUPING IS THE STORE EJECTED WITH THE
          TRAJECTORY STARTING ONE RADIUS BELOW THE CARRIAGE POSITION
     IT IS A FREE-FLIGHT TRAJECTORY, NOT A CAPTIVE STORE TRAJECTORY
     DAMPING IS INCLUDED
     THE AIRCRAFT IS DIVING AT A FLIGHT PATH ANGLE OF -30 DEGREES


AIRCRAFT FLIGHT CONDITIONS
     ANGLE OF ATTACK =  6.00 DEGREES
     FLIGHT PATH ANGLE =-30.00 DEGREES
     MACH NUMBER =  .40
     FREE STREAM MASS DENSITY =   .0020482 SLUGS PER CUBIC FOOT
     FREE STREAM VELOCITY =  440.70 FEET PER SECOND


FUSELAGE INPUT DATA
     FUSELAGE LENGTH =  60.85000 FEET
     MAXIMUM RADIUS =   2.78340 FEET


                              INCOMPRESSIBLE SOURCE DISTRIBUTION

     X/L   2.00000E-03 2.53000E-03 3.20060E-03 4.04870E-03 5.12060E-03 6.47450E-03 8.18310E-03 1.03370E-02
     Q*(K) 6.07530E-06-5.47820E-06 3.53980E-06-2.17850E-06 1.61620E-06-6.69620E-07 1.04450E-06 3.10400E-07

     X/L   1.30480E-02 1.64560E-02 2.07290E-02 2.60720E-02 3.27300E-02 4.09930E-02 5.11920E-02 6.36970E-02
     Q*(K) 1.37370E-06 1.60040E-06 2.87800E-06 4.22660E-06 6.64360E-06 9.93870E-06 1.48130E-05 2.14030E-05

     X/L   7.89070E-02 9.72240E-02 1.19020E-01 1.44580E-01 1.74060E-01 2.07370E-01 2.44150E-01 2.83720E-01
     Q*(K) 3.00830E-05 4.05820E-05 5.20730E-05 6.24870E-05 6.87670E-05 6.29460E-05 7.32610E-05 4.50690E-06

     X/L   3.25080E-01 3.66960E-01 4.08850E-01 4.50730E-01 4.92620E-01 5.34500E-01 5.76390E-01 6.18270E-01
     Q*(K)-7.68290E-07-1.27660E-05 9.99140E-06-1.15010E-05 1.07170E-05-1.10600E-05 1.10630E-05-1.07030E-05

     X/L   6.60160E-01 7.02040E-01 7.43930E-01 7.85810E-01 8.27450E-01 8.68050E-01 9.06870E-01 9.43260E-01
     Q*(K) 1.15550E-05-9.89930E-06 1.64960E-05-1.32980E-05-3.14260E-05-4.55380E-05-5.38350E-05-5.64920E-05

     X/L   9.76730E-01 1.00700E+00 1.03380E+00 1.05730E+00 1.07760E+00 1.09480E+00 1.10940E+00 1.12150E+00
     Q*(K)-5.39670E-05-4.82290E-05-4.03720E-05-3.24970E-05-2.47050E-05-1.86520E-05-1.30210E-05-9.74060E-06

     X/L   1.13160E+00 1.13990E+00 1.14670E+00 1.15220E+00 1.15670E+00 1.16030E+00 1.16320E+00 1.16560E+00
     Q*(K)-5.94580E-06-5.11050E-06-1.93940E-06-3.36030E-06 7.12840E-07-3.64580E-05 3.49100E-06-6.00770E-06

     X/L   1.16750E+00 1.16900E+00
     Q*(K) 8.06400E-06-9.41390E-06
```

(a) Page 1.

Figure 23.- Trajectory program output for sample case 2.

WING INPUT DATA

LOCATION OF WING ROOT CHORD LEADING EDGE RELATIVE TO FUSELAGE NOSE
XF = -22.45600 FEET
ZF = 0.00000 FEET
INCIDENCE ANGLE OF WING ROOT CHORD RELATIVE TO FUSELAGE AXIS
IW = 0.00 DEGREES
LENGTH OF WING ROOT CHORD
CRW = 15.41200 FEET
WING SEMISPAN
SSPAN = 20.00000 FEET

40 VORTICES ARE TO BE LAID OUT ON EACH WING PANEL
5 CHORDWISE ROWS WITH 8 IN EACH ROW

SPANWISE LOCATIONS OF TRAILING VORTEX LEGS AND SWEEP ANGLES AND DIHEDRAL ANGLE OF WING SECTION TO THE RIGHT

I	SPANWISE LOCATION FEET	LE SWEEP DEGREES	TE SWEEP DEGREES	DIHEDRAL DEGREES
1	0.00000	0.00000	0.00000	0.00000
2	-3.33333	48.60000	30.75000	0.00000
3	-6.66667	48.60000	30.75000	0.00000
4	-10.00000	48.60000	30.75000	0.00000
5	-15.00000	48.60000	30.75000	0.00000
6	-20.00000	48.60000	30.75000	0.00000

80 THICKNESS PANELS ARE TO BE LAID OUT ON EACH WING PANEL
5 CHORDWISE ROWS WITH 16 IN EACH ROW
THE CHORDWISE ROWS COINCIDE WITH THOSE USED
IN THE VORTEX LATTICE

(b) Page 2.

Figure 23.- Continued.

```
PYLON INPUT DATA

    LEADING EDGE OF PYLON ROOT CHORD IS AT X=  -8.24583 FEET (MEASURED FROM LOCAL WING LEADING EDGE)
    SPANWISE LOCATION IS Y=    0.00000 FEET
    ROOTCHORD =    3.33333 FEET
    HEIGHT =    1.65200 FEET
    LEADING EDGE SWEEP ANGLE =    0.00000 DEGREES
    TRAILING EDGE SWEEP ANGLE =    0.00000 DEGREES


      4 VORTICES ARE TO BE LAID OUT ON THE PYLON
           2 CHORDWISE ROWS WITH  2 IN EACH ROW

    SPANWISE LOCATIONS OF TRAILING VORTEX LEGS

         K          Z
                  FEET
         1       2.78340
         2       3.60940
         3       4.43540


    120 THICKNESS PANELS ARE TO BE LAID OUT ON THE PYLON
           2 CHORDWISE ROWS WITH 60 IN EACH ROW
          THE CHORDWISE ROWS COINCIDE WITH THOSE USED
          IN THE VORTEX LATTICE
```

(c) Page 3.

Figure 23.- Continued.

VORTEX LATTICE CONTROL POINT COORDINATES AND
INPUT TWIST AND CAMBER DISTRIBUTION
AT THESE POINTS
(WING COORDINATE SYSTEM)

WING CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	SLOPE
1	1	-3.25106	-1.66667	0.00000	0.00000
1	2	-5.06520	-1.66667	0.00000	0.00000
1	3	-6.87934	-1.66667	0.00000	0.00000
1	4	-8.69348	-1.66667	0.00000	0.00000
1	5	-10.50761	-1.66667	0.00000	0.00000
1	6	-12.32175	-1.66667	0.00000	0.00000
1	7	-14.13589	-1.66667	0.00000	0.00000
1	8	-15.95003	-1.66667	0.00000	0.00000
2	1	-6.86345	-5.00000	0.00000	0.00000
2	2	-8.45286	-5.00000	0.00000	0.00000
2	3	-10.04227	-5.00000	0.00000	0.00000
2	4	-11.63168	-5.00000	0.00000	0.00000
2	5	-13.22110	-5.00000	0.00000	0.00000
2	6	-14.81051	-5.00000	0.00000	0.00000
2	7	-16.39992	-5.00000	0.00000	0.00000
2	8	-17.98933	-5.00000	0.00000	0.00000
3	1	-10.47583	-8.33333	0.00000	0.00000
3	2	-11.84052	-8.33333	0.00000	0.00000
3	3	-13.20520	-8.33333	0.00000	0.00000
3	4	-14.56989	-8.33333	0.00000	0.00000
3	5	-15.93458	-8.33333	0.00000	0.00000
3	6	-17.29927	-8.33333	0.00000	0.00000
3	7	-18.66395	-8.33333	0.00000	0.00000
3	8	-20.02864	-8.33333	0.00000	0.00000
4	1	-14.99130	-12.50000	0.00000	0.00000
4	2	-16.07508	-12.50000	0.00000	0.00000
4	3	-17.15887	-12.50000	0.00000	0.00000
4	4	-18.24265	-12.50000	0.00000	0.00000
4	5	-19.32643	-12.50000	0.00000	0.00000
4	6	-20.41021	-12.50000	0.00000	0.00000
4	7	-21.49399	-12.50000	0.00000	0.00000
4	8	-22.57777	-12.50000	0.00000	0.00000
5	1	-20.40987	-17.50000	0.00000	0.00000
5	2	-21.15657	-17.50000	0.00000	0.00000
5	3	-21.90326	-17.50000	0.00000	0.00000
5	4	-22.64996	-17.50000	0.00000	0.00000
5	5	-23.39665	-17.50000	0.00000	0.00000
5	6	-24.14334	-17.50000	0.00000	0.00000
5	7	-24.89004	-17.50000	0.00000	0.00000
5	8	-25.63673	-17.50000	0.00000	0.00000

PYLON CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT
1	1	-9.49583	0.00000	3.19640
1	2	-11.16249	0.00000	3.19640
2	1	-9.49583	0.00000	4.02240
2	2	-11.16249	0.00000	4.02240

(d) Page 4.

Figure 23.- Continued.

INPUT VALUES OF THE LOCAL SURFACE SLOPE OF THE THICKNESS
DISTRIBUTION. FOR EACH CHORDWISE ROW THE FIRST VALUE
IS FOR THE PANEL NEAREST THE LEADING EDGE

WING THICKNESS DATA

ROW				SLOPES				
1	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
2	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
3	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
4	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719
5	.18074	.09400	.06400	.04460	.02800	.01955	-.00122	-.01341
	-.02561	-.03782	-.05005	-.06000	-.06600	-.06719	-.06719	-.06719

PYLON THICKNESS DATA

ROW				SLOPES				
1	1.74060	.75020	.35360	.06686	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	-.06686	-.35360	-.75020	-1.74060				
2	1.74060	.75020	.35360	.06686	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
	-.06686	-.35360	-.75020	-1.74060				

(e) Page 5.

Figure 23.- Continued.

```
RACK INPUT DATA

     RACK LENGTH =  5.56833 FEET
     MAXIMUM RADIUS =   .31667 FEET
     LOCATION OF RACK NOSE RELATIVE TO LOCAL WING LEADING EDGE
          X = -7.12833 FEET
          Z =  4.75207 FEET
     RACK INCIDENCE ANGLE RELATIVE TO WING ROOT CHORD
          IR =  0.00000 DEGREES


                                INCOMPRESSIBLE SOURCE DISTRIBUTION

     X/L    2.00000E-03 5.99370E-03 1.28790E-02 2.28990E-02 3.61190E-02 5.24850E-02 7.18530E-02 9.40060E-02
     Q*(K)-5.66440E-07 2.04470E-05 5.21430E-05 6.60020E-05 8.00620E-05 8.86210E-05 9.26910E-05 9.08970E-05

     X/L    1.18660E-01 1.45480E-01 1.74080E-01 2.04040E-01 2.34880E-01 2.66130E-01 2.97400E-01 3.28670E-01
     Q*(K) 8.20190E-05 7.57630E-05 1.78350E-05 1.20500E-04-1.18400E-04 5.38280E-05-5.13060E-05 4.57470E-05

     X/L    3.59950E-01 3.91220E-01 4.22490E-01 4.53770E-01 4.85040E-01 5.16310E-01 5.47590E-01 5.78860E-01
     Q*(K)-4.82800E-05 4.64540E-05-4.76690E-05 4.68620E-05-4.73570E-05 4.71190E-05-4.71250E-05 4.73480E-05

     X/L    6.10130E-01 6.41410E-01 6.72680E-01 7.03950E-01 7.35230E-01 7.66500E-01 7.97770E-01 8.29050E-01
     Q*(K)-4.68770E-05 4.76410E-05-4.65040E-05 4.81510E-05-4.57760E-05 4.93870E-05-4.45210E-05 5.80370E-05

     X/L    8.60320E-01 8.91590E-01 9.22870E-01 9.52780E-01 9.78670E-01 9.98690E-01 1.01230E+00
     Q*(K)-7.46670E-05 2.81500E-04-2.91260E-04-3.08560E-04-2.14530E-04-7.91270E-05-4.65230E-05
```

(f) Page 6.

Figure 23.- Continued.

STORE INPUT DATA

STORE NO	SHAPE NO	LENGTH FT	MAXIMUM RADIUS FT	STORE LOCATION RELATIVE TO LOCAL WING CHORD LEADING EDGE X, FT	Y, FT	Z, FT	INCIDENCE ANGLE DEG
10	5	7.38333	.44667	-1.02750	-6.66667	1.98612	0.00000
20	2	10.62500	.62500	-4.60000	0.00000	6.52167	0.00000
21	2	10.62500	.62500	-3.61720	-.86667	4.96333	0.00000
22	2	10.62500	.62500	-3.61720	.86667	4.96333	0.00000
30	5	7.38333	.44667	-1.02750	6.66667	1.98612	0.00000

SOURCE DISTRIBUTION FOR SHAPE NO 5

INCOMPRESSIBLE SOURCE DISTRIBUTION

X/L	2.00000E-03	2.86920E-03	4.10680E-03	5.86250E-03	8.33990E-03	1.18100E-02	1.66190E-02	2.31920E-02
Q*(K)	3.89500E-06	-2.94050E-06	1.89690E-06	5.60640E-07	2.62880E-06	4.79150E-06	9.73390E-06	1.84190E-05
X/L	3.20070E-02	4.35380E-02	5.81460E-02	7.59810E-02	9.71890E-02	1.21590E-01	1.48620E-01	1.77420E-01
Q*(K)	3.24180E-05	5.36170E-05	5.64720E-05	9.35680E-05	8.97160E-05	9.58660E-05	-5.88680E-05	1.34570E-04
X/L	2.07790E-01	2.39800E-01	2.73540E-01	3.09090E-01	3.46530E-01	3.85800E-01	4.26440E-01	4.67910E-01
Q*(K)	-2.04990E-05	1.29040E-04	1.05120E-05	1.34660E-04	9.01540E-05	-2.61210E-05	1.27540E-04	-1.06930E-04
X/L	5.09580E-01	5.50810E-01	5.90970E-01	6.29480E-01	6.65840E-01	6.99650E-01	7.30650E-01	7.58810E-01
Q*(K)	6.58560E-05	-1.74060E-04	3.10920E-05	-2.33650E-04	4.96120E-05	-2.86510E-04	8.20150E-05	-2.07990E-04
X/L	7.84920E-01	8.09700E-01	8.33720E-01	8.57460E-01	8.81190E-01	9.04930E-01	9.28670E-01	9.52410E-01
Q*(K)	1.68710E-04	-2.17830E-04	2.24930E-04	-2.10590E-04	2.13690E-04	-2.09990E-04	2.13880E-04	-2.05820E-04
X/L	9.76140E-01	9.99880E-01	1.02360E+00	1.04350E+00				
Q*(K)	1.94700E-04	2.26620E-05	-4.13870E-04	1.84640E-05				

SOURCE DISTRIBUTION FOR SHAPE NO 2

INCOMPRESSIBLE SOURCE DISTRIBUTION

X/L	2.00000E-03	2.64730E-03	3.51320E-03	4.67050E-03	6.21490E-03	8.27210E-03	1.10060E-02	1.46260E-02
Q*(K)	4.85130E-06	-4.32150E-06	2.44260E-06	-7.10540E-07	1.26380E-06	1.09350E-06	2.57490E-06	4.32910E-06
X/L	1.94000E-02	2.56610E-02	3.38100E-02	4.43160E-02	5.76990E-02	7.44850E-02	9.51450E-02	1.19990E-01
Q*(K)	7.80300E-06	1.35100E-05	2.30180E-05	3.79470E-05	5.99540E-05	8.95020E-05	1.22140E-04	1.54820E-04
X/L	1.49040E-01	1.81940E-01	2.17810E-01	2.55310E-01	2.93050E-01	3.30790E-01	3.68520E-01	4.06260E-01
Q*(K)	1.28200E-04	2.02610E-04	-5.04760E-05	-1.13980E-04	1.15940E-04	-1.24680E-04	1.20500E-04	-1.23260E-04
X/L	4.44000E-01	4.81730E-01	5.19470E-01	5.57210E-01	5.94940E-01	6.32680E-01	6.70420E-01	7.08150E-01
Q*(K)	1.21440E-04	-1.22660E-04	1.21850E-04	-1.22350E-04	1.22110E-04	-1.22130E-04	1.22330E-04	-1.21880E-04
X/L	7.45890E-01	7.83630E-01	8.21360E-01	8.59100E-01	8.96840E-01	9.34570E-01	9.72310E-01	1.01000E+00
Q*(K)	1.22630E-04	-1.21490E-04	1.23180E-04	-1.20630E-04	-1.74950E-04	-1.39120E-04	-9.35870E-05	-5.42850E-05
X/L	1.04770E+00	1.08400E+00	1.11710E+00	1.14590E+00	1.16970E+00	1.18840E+00	1.20250E+00	1.21270E+00
Q*(K)	-2.99660E-05	-1.25300E-05	1.24500E-04	-1.16740E-04	1.16950E-04	1.14800E-05	-1.19240E-04	-1.72710E-04
X/L	1.22000E+00	1.22500E+00	1.22840E+00					
Q*(K)	-1.02270E-05	4.66400E-06	-1.17130E-05					

(g) Page 7.

Figure 23.- Continued.

VORTEX LATTICE CONTROL POINT COORDINATES
INTERFERENCE VELOCITIES INDUCED AT THESE POINTS
CALCULATED VORTEX STRENGTHS
(WING COORDINATE SYSTEM)

WING CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	U/VINF	V/VINF	W/VINF	GAMMA/VINF
1	1	-3.25106	-1.66667	0.00000	.00327	-.00212	-.00732	.71264
1	2	-5.06520	-1.66667	0.00000	.00036	-.00282	-.01010	.37258
1	3	-6.87934	-1.66667	0.00000	-.00490	-.00264	-.01013	.27577
1	4	-8.69348	-1.66667	0.00000	-.01025	-.00110	-.00513	.20999
1	5	-10.50761	-1.66667	0.00000	-.01227	.00115	.00080	.15959
1	6	-12.32175	-1.66667	0.00000	-.00959	.00218	.00653	.12661
1	7	-14.13589	-1.66667	0.00000	-.00499	.00208	.00507	.10268
1	8	-15.95003	-1.66667	0.00000	-.00062	.00184	.00894	.07232
2	1	-6.86345	-5.00000	0.00000	-.00139	-.00223	-.00540	.77807
2	2	-8.45286	-5.00000	0.00000	-.00369	.00118	-.00651	.37343
2	3	-10.04227	-5.00000	0.00000	-.00890	.00384	-.00544	.25815
2	4	-11.63168	-5.00000	0.00000	-.01217	.00259	.00027	.18770
2	5	-13.22110	-5.00000	0.00000	-.00861	-.00009	.00659	.14443
2	6	-14.81051	-5.00000	0.00000	-.00266	.00020	.00776	.12187
2	7	-16.39992	-5.00000	0.00000	.00064	.00090	.00692	.09810
2	8	-17.98933	-5.00000	0.00000	.00246	.00186	.00473	.06663
3	1	-10.47583	-8.33333	0.00000	-.00717	-.00373	-.00445	.75537
3	2	-11.84052	-8.33333	0.00000	-.00950	.00039	-.00001	.34811
3	3	-13.20520	-8.33333	0.00000	-.00685	.00450	.00451	.23880
3	4	-14.56989	-8.33333	0.00000	-.00264	.00545	.00539	.18661
3	5	-15.93458	-8.33333	0.00000	-.00034	.00512	.00487	.15127
3	6	-17.29927	-8.33333	0.00000	.00142	.00402	.00357	.12191
3	7	-18.66395	-8.33333	0.00000	.00162	.00281	.00222	.09249
3	8	-20.02864	-8.33333	0.00000	.00142	.00209	.00151	.05813
4	1	-14.99130	-12.50000	0.00000	-.00137	.00164	.00063	.67276
4	2	-16.07508	-12.50000	0.00000	-.00089	.00178	.00068	.32134
4	3	-17.15887	-12.50000	0.00000	-.00048	.00176	.00068	.22649
4	4	-18.24265	-12.50000	0.00000	-.00015	.00165	.00064	.17369
4	5	-19.32643	-12.50000	0.00000	.00008	.00149	.00058	.13620
4	6	-20.41021	-12.50000	0.00000	.00023	.00131	.00052	.10570
4	7	-21.49399	-12.50000	0.00000	.00032	.00115	.00046	.07788
4	8	-22.57777	-12.50000	0.00000	.00038	.00100	.00040	.04842
5	1	-20.40987	-17.50000	0.00000	-.00013	.00063	.00017	.52053
5	2	-21.15657	-17.50000	0.00000	-.00008	.00061	.00017	.24671
5	3	-21.90326	-17.50000	0.00000	-.00003	.00059	.00016	.17188
5	4	-22.64996	-17.50000	0.00000	.00001	.00056	.00015	.12958
5	5	-23.39665	-17.50000	0.00000	.00004	.00054	.00015	.09911
5	6	-24.14334	-17.50000	0.00000	.00007	.00051	.00014	.07449
5	7	-24.89004	-17.50000	0.00000	.00010	.00048	.00013	.05295
5	8	-25.63673	-17.50000	0.00000	.00011	.00045	.00012	.03176

PYLON CONTROL POINTS

ROW	VORTEX	X, FT	Y, FT	Z, FT	V/VINF	GAMMA/VINF
1	1	-9.49583	0.00000	3.19640	0.00000	0.00000
1	2	-11.16249	0.00000	3.19640	0.00000	0.00000
2	1	-9.49583	0.00000	4.02240	0.00000	0.00000
2	2	-11.16249	0.00000	4.02240	0.00000	0.00000

(h) Page 8.

Figure 23.- Continued.

```
STORE NUMBER   20 IS THE STORE EJECTED

    ADDITIONAL INPUT FOR THIS STORE
         STORE MASS =  15.53000 SLUGS
         MOMENTS AND PRODUCTS OF INERTIA, SLUG - SQ FT
            IXX =   8.00000
            IYY =  80.00000
            IZZ =  80.00000
            IYZ =  -0.00000
            IXZ =  -0.00000
            IXY =  -0.00000
         STORE MOMENT CENTER IS -5.31250 FEET BEHIND NOSE
         STORE CENTER OF GRAVITY OFFSET FROM MOMENT CENTER, FEET
            XBAR = -0.00000
            YBAR = -0.00000
            ZBAR = -0.00000
         POLYNOMIALS SPECIFYING COMPRESSIBLE STORE SHAPE
            X/L OF END OF EACH SECTION
               SECTION      X/L
                  1        .23530
                  2       1.10000
            COEFFICIENTS OF POLYNOMIALS DESCRIBING EACH SECTION
               SECTION      C1         C2         C3         C4         C5         C6         C7
                  1       -.44130  -1.00000     .47060     .19470  -0.00000  -0.00000   1.00000
                  2        .05882  -0.00000  -0.00000  -0.00000  -0.00000  -0.00000  -0.00000
         SEPARATION ASSUMED  10.62500 FEET FROM NOSE
         AXIAL-FORCE COEFFICIENT IS     .20000
         CROSSFLOW-DRAG COEFFICIENT IS   0.00000
```

(i) Page 9.

Figure 23.- Continued.

TIME = 0.00000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	.18343	.00000	.06514	-.00000	
SLENDER BODY	.29073	.00000	.42578	-.00000	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	.47416	.00000	.49092	-.00000	0.00000

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	.03468	-.00000	.97498	-.00000	.06275
.79688	.07500	.04156	.00000	.98634	-.00000	.05091
1.32813	.12500	.06205	-.00000	1.00382	-.00000	.04728
1.85938	.17500	.10835	.00000	1.01971	-.00000	.05398
2.39063	.22500	.09988	.00000	1.02738	-.00000	.06626
2.92188	.27500	.07064	-.00000	1.02815	-.00000	.07713
3.45313	.32500	.05709	0.00000	1.02730	0.00000	.08541
3.98438	.37500	.04988	.00000	1.02629	-.00000	.09250
4.51563	.42500	.04264	-.00000	1.02510	-.00000	.09864
5.04688	.47500	.03727	.00000	1.02406	-.00000	.10390
5.57813	.52500	.03519	0.00000	1.02342	-.00000	.10865
6.10938	.57500	.03619	.00000	1.02317	0.00000	.11335
6.64063	.62500	.03977	-.00000	1.02318	.00000	.11836
7.17188	.67500	.04409	.00000	1.02308	.00000	.12395
7.70313	.72500	.04350	-.00000	1.02225	.00000	.12988
8.23438	.77500	.04369	.00000	1.02095	.00000	.13550
8.76563	.82500	.05415	.00000	1.01911	.00000	.14195
9.29688	.87500	.04398	-.00000	1.01321	.00000	.14917
9.82813	.92500	-.00334	.00000	1.00229	.00000	.15224
10.35937	.97500	-.04871	.00000	.99185	.00000	.14839

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-27.06600	0.00000	6.52167	.00000	0.00000	0.00000
XMOM	-32.37850	0.00000	6.52167	0.00000	0.00000	0.00000
BASE	-37.69100	0.00000	6.52167	.00000	0.00000	0.00000

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM

RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
0.00000	0.00000	10.00000	9.92643	.00000	21.90089

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
0.00000	0.00000	0.00000	0.00000	1.88211	-.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES

ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

(j) Page 10.

Figure 23.- Continued.

TIME = .30000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	.07784	-.00000	-.01707	-.00000	
SLENDER BODY	.55624	-.00000	1.58336	-.00000	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	.63408	-.00000	1.56630	-.00000	0.00000

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	.14619	-.00000	.97259	-.00000	.23320
.79688	.07500	.28308	-.00000	.97360	-.00000	.23456
1.32813	.12500	.27862	-.00000	.97466	-.00000	.23623
1.85938	.17500	.18764	-.00000	.97568	-.00000	.23823
2.39063	.22500	.04934	-.00000	.97657	-.00000	.24049
2.92188	.27500	.01898	.00000	.97727	-.00000	.24294
3.45313	.32500	.01960	-.00000	.97776	-.00000	.24551
3.98438	.37500	.01978	-.00000	.97805	-.00000	.24813
4.51563	.42500	.01965	-.00000	.97816	-.00000	.25076
5.04688	.47500	.01932	.00000	.97811	-.00000	.25335
5.57813	.52500	.01884	.00000	.97792	-.00000	.25588
6.10938	.57500	.01825	-.00000	.97761	-.00000	.25835
6.64063	.62500	.01757	-.00000	.97719	-.00000	.26073
7.17188	.67500	.01678	.00000	.97668	-.00000	.26301
7.70313	.72500	.01589	-.00000	.97609	-.00000	.26518
8.23438	.77500	.01490	-.00000	.97544	-.00000	.26723
8.76563	.82500	.01385	.00000	.97474	-.00000	.26914
9.29688	.87500	.01277	-.00000	.97402	-.00000	.27091
9.82813	.92500	.01173	.00000	.97330	-.00000	.27253
10.35937	.97500	.01080	.00000	.97263	-.00000	.27403

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-26.81643	-.00000	9.88946	.24957	-.00000	3.36779
XMOM	-32.08861	.00000	10.54276	.28989	.00000	4.02109
BASE	-37.36079	.00000	11.19606	.33021	.00000	4.67439

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM
RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
1.05909	.00000	16.76721	-8.52429	-.00000	20.84069

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
0.00000	1.02605	-.00000	0.00000	6.05830	-.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES
ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
-.00000	7.06378	-.00000	-.00000	1.02605	-.00000

(k) Page 11.

Figure 23.- Continued.

TIME = .60000 SECONDS

FORCE AND MOMENT COEFFICIENTS

	CN	CY	CLM	CLN	CLL
BUOYANCY	.20715	-.00000	-.08336	.00000	
SLENDER BODY	1.84408	-.00000	5.39251	-.00000	
CROSSFLOW	0.00000	0.00000	0.00000	0.00000	
EMPENNAGE	0.00000	0.00000	0.00000	0.00000	0.00000
TOTAL	2.05123	-.00000	5.30915	-.00000	0.00000

LOAD AND VELOCITY DISTRIBUTIONS

X, FT	X/L	DCN/DX	DCY/DX	U/VS	V/VS	W/VS
.26563	.02500	.50009	-.00000	.53810	-.00000	.79656
.79688	.07500	.97125	-.00000	.53715	-.00000	.80284
1.32813	.12500	.95327	-.00000	.53627	-.00000	.80900
1.85938	.17500	.63356	-.00000	.53547	-.00000	.81506
2.39063	.22500	.15259	-.00000	.53473	-.00000	.82106
2.92188	.27500	.04447	-.00000	.53406	-.00000	.82699
3.45313	.32500	.04414	-.00000	.53345	-.00000	.83287
3.98438	.37500	.04387	-.00000	.53289	-.00000	.83872
4.51563	.42500	.04365	-.00000	.53238	-.00000	.84453
5.04688	.47500	.04348	-.00000	.53191	-.00000	.85032
5.57813	.52500	.04335	-.00000	.53149	-.00000	.85608
6.10938	.57500	.04324	-.00000	.53110	-.00000	.86183
6.64063	.62500	.04318	-.00000	.53074	-.00000	.86757
7.17188	.67500	.04309	-.00000	.53041	-.00000	.87330
7.70313	.72500	.04305	-.00000	.53011	-.00000	.87902
8.23438	.77500	.04302	-.00000	.52984	-.00000	.88474
8.76563	.82500	.04299	-.00000	.52958	-.00000	.89045
9.29688	.87500	.04297	-.00000	.52934	-.00000	.89616
9.82813	.92500	.04295	-.00000	.52912	-.00000	.90187
10.35937	.97500	.04294	-.00000	.52891	-.00000	.90757

LOCATION OF STORE IN FUSELAGE COORDINATE SYSTEM, DIMENSIONS OF FEET

	RELATIVE TO FUSELAGE NOSE			RELATIVE TO INITIAL POSITION		
	XF	YF	ZF	DEL XF	DEL YF	DEL ZF
NOSE	-29.69661	-.00000	12.02494	-2.63061	-.00000	5.50327
XMOM	-33.12118	-.00000	16.08634	-.74268	-.00000	9.56467
BASE	-36.54575	.00000	20.14774	1.14525	.00000	13.62607

TRANSLATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN FUSELAGE COORDINATE SYSTEM

RELATIVE TO FUSELAGE MOTION

DXF	DYF	DZF	D2XF	D2YF	D2ZF
-12.30185	-.00000	17.18356	-92.12300	-.00000	-45.24369

ROTATIONAL VELOCITIES AND ACCELERATIONS OF STORE IN STORE COORDINATE SYSTEM

P	Q	R	PDOT	QDOT	RDOT
0.00000	4.64040	-.00000	0.00000	19.33546	-.00000

STORE ANGULAR ORIENTATION IN FUSELAGE COORDINATE SYSTEM AND RATES OF CHANGE OF THESE ANGLES

ANGLES IN DEGREES, RATES OF CHANGE IN RADIANS PER SECOND

PSI	THETA	PHI	DPSI	DTHETA	DPHI
-.00000	49.86243	-.00000	-.00000	4.64040	-.00000

(1) Page 12.

Figure 23.- Concluded.

APPENDIX I

DETAILS OF SOURCE DISTRIBUTION PROGRAM

I-1. INTRODUCTION

The purpose of this appendix is to provide more detailed information on the source distribution program which was described in section 3. A listing of the program was presented in figure 1 and a general flow chart in figure 2. This appendix will present more detailed flow charts and tables equating the program notation to the algebraic notation.

I-2. MAIN PROGRAM

The flow chart of the main program is presented in figure I-1 and the table equating the program notation and the algebraic notation is presented in Table I-1. Referring to figure I-1, the first section of the program reads and prints the input data. These data were discussed in detail in section 3.2.1. The next section determines the source locations. The first source is placed at x/ℓ = XSFST, an input quantity. The location of source $j + 1$ is given by

$$\left(\frac{x}{\ell}\right)_{j+1} = \left(\frac{x}{\ell}\right)_j + \text{PERCR}\left[\beta\left(\frac{r}{\ell}\right)_j\right]$$

The quantity PERCR was input and $(r/\ell)_j$, as well as $(dr/dx)_j$, is calculated in subroutine SHAPE. They are the body radius and surface slope at the j^{th} source location and are calculated from the input polynomials specifying the body shape. After calculating this information for all source locations it is printed.

The values of r/ℓ and dr/dx at the (NSORC - 2) points where the flow tangency boundary condition is to be applied are next determined. For a discussion of this, see section 4.1.2 of reference 2. These points are located midway between sources. Since this condition is to be imposed at (NSORC - 2) points, one position must be eliminated since there are (NSORC - 1) of these positions. The one eliminated is the third one ahead of the point where the maximum body radius is first reached, XRMAX which was input.

The next part of the program calculates the coefficient matrix and the right-hand side of the set of simultaneous equations which are to be solved in order to determine the source strengths. The set of simultaneous equations is given by equations (19), (20), and (21) of reference 2. Note that the right-hand side is put in the (NSORC + 1) column of the C array.

Subroutine INVERS is next called to solve the set of equations for the source strengths. Upon returning from the subroutine the solution is in the (NSORC + 1) column of the C array. This solution is transferred to the Q array and the x/ℓ locations and the source strengths are printed.

The last section of the program calculates the body shape given by the source distribution using equation (14) of reference 2. On the body surface the value of the stream function, ψ^*, is zero. An iteration on r^* is performed to find the value which gives $\psi^* = 0$. This is done at points as specified by the input data.

I-3. SUBROUTINE INVERS

Subroutine INVERS solves a set of simultaneous linear algebraic equations by Gaussian elimination. This routine comes from reference 5 which contains a flow chart. Not all of the options shown in that flow chart are in the present routine. The quantities in the parameter list are

A	array containing coefficient matrix and right-hand sides
NSYS	number of right-hand sides
N	number of equations
NMAX	first dimension of A array in calling program
MMAX	second dimension of A array in calling program

I-4. SUBROUTINE SHAPE

The purpose of this subroutine is to calculate the body radius and surface slope at a specified axial station. The body shape is specified by a series of polynomials of the form of equation (1) of this report. A flow chart of subroutine SHAPE is presented in figure I-2 and a table equating the program notation and the algebraic notation is presented in Table I-2.

The quantities in the parameter list are:

X	value of x/ℓ at which radius and surface slope are to be calculated
NS	number of polynomials describing body shape
XE	array containing values of x/ℓ for the end points of the NS polynomials
C	array containing the coefficients of the NS polynomials
R	calculated value of r/ℓ at $x/\ell = X$
DRDX	calculated value of dr/dx at $x/\ell = X$

The calculation performed by this subroutine consists of two steps. The first step is to determine which of the NS polynomials describes the shape at the value of X where the radius and surface slope is required. Once this is determined, the appropriate set of coefficients is used in equation (1) to determine r/ℓ. The value of dr/dx is found by differentiating equation (1).

$$\frac{dr}{dx} = \frac{C_7}{2}\left[\frac{2C_2\,\frac{x}{\ell} + C_3}{\sqrt{C_2\left(\frac{x}{\ell}\right)^2 + C_3\,\frac{x}{\ell} + C_4}}\right] + C_5 + 2C_6\,\frac{x}{\ell}$$

TABLE I-1

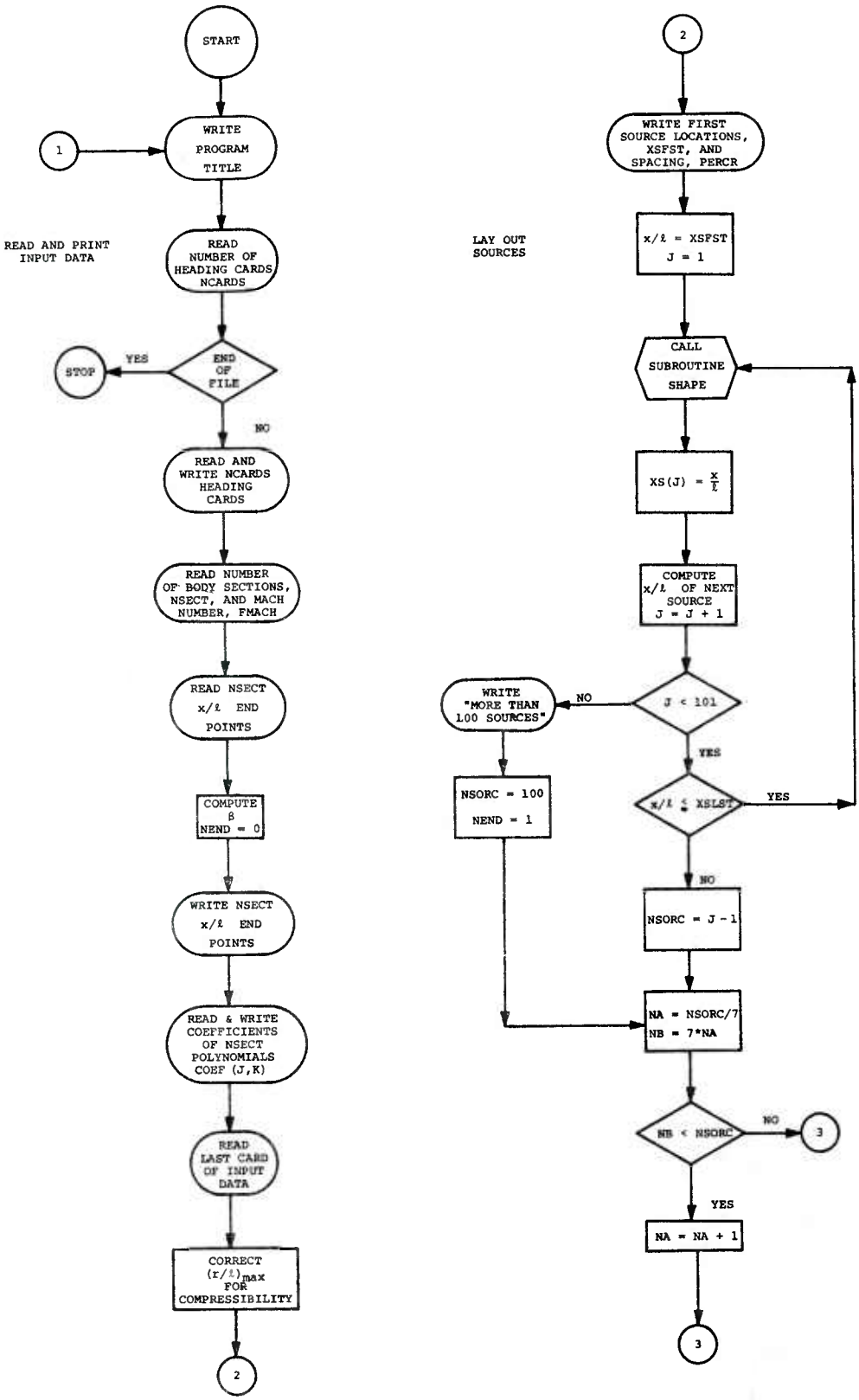
DICTIONARY OF NOTATION
IN MAIN PROGRAM

PROGRAM NOTATION	ALGEBRAIC NOTATION
BETA	$\sqrt{1 - M_\infty^2}$
DRDX(K)	body surface slope, dr/dx, at location of k^{th} source
FMACH	M_∞
NSORC	number of sources
PSI	stream function, ψ^* (eq. (14), ref. 2)
Q(K)	strength of k^{th} source, Q_k^* (eqs. (14), (19), (20) and (21), ref. 2)
RA(J)	body radius at the j^{th} flow tangency boundary condition, r_j^* (eq. (19), ref. 2)
RL(K)	body radius at k^{th} source location, r_k^* (eqs. (14), (19) and (21), ref. 2)
TB(J)	body surface slope at j^{th} flow tangency boundary condition, $\tan \beta_j$ (eq. (19), ref. 2)
XC(J)	x/ℓ of j^{th} flow tangency boundary condition, x_j^* (eq. (19), ref. 2)
XS(K)	x/ℓ of k^{th} source, x_k^* (eqs. (14), (19) and (21), ref. 2)

TABLE I-2

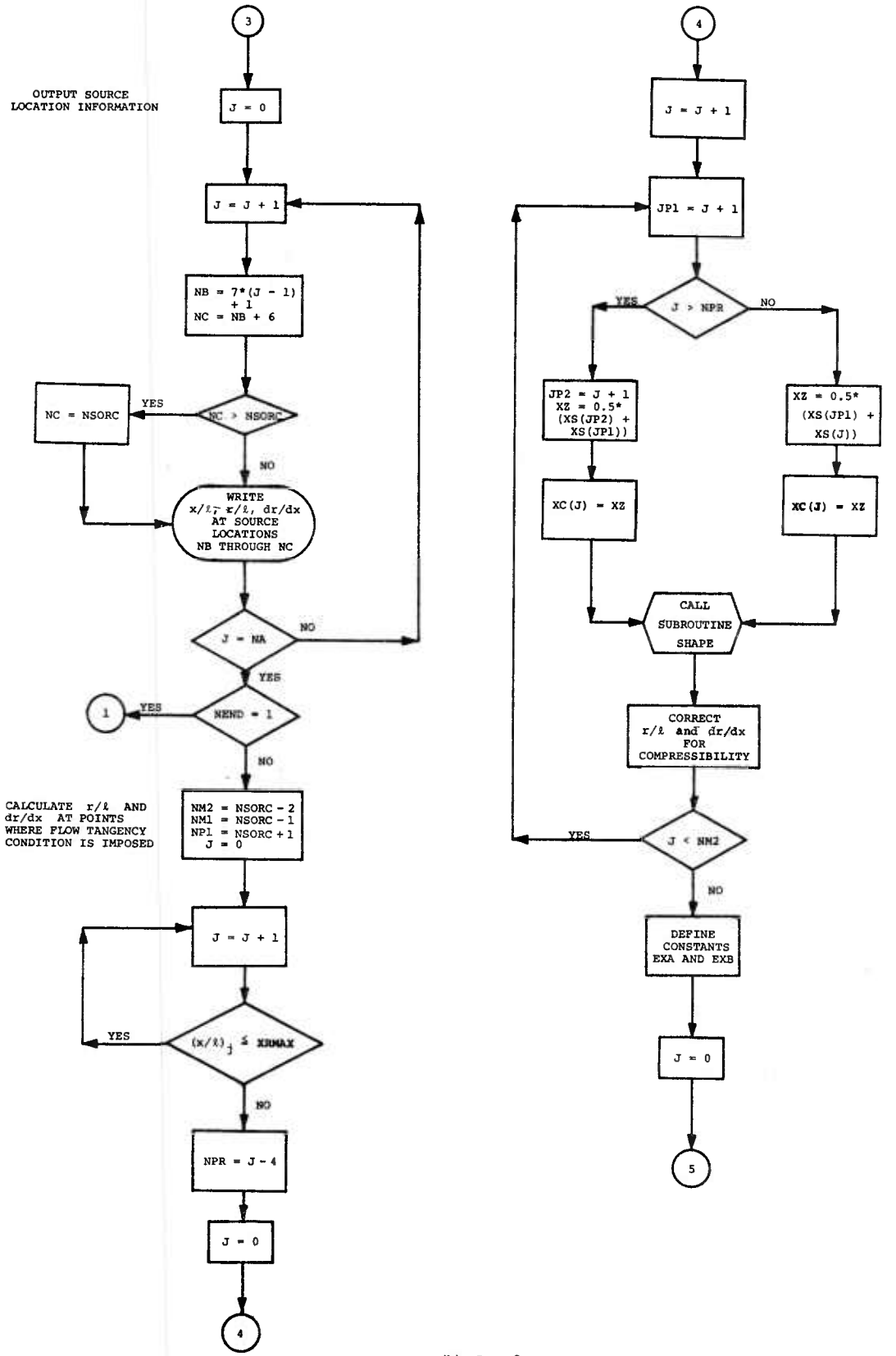
DICTIONARY OF NOTATION
IN SUBROUTINE SHAPE

PROGRAM NOTATION	ALGEBRAIC NOTATION
C(J,N) J = 1,2,...7	C_1, C_2,...C_7 of the n^{th} polynomial
DRDX	dr/dx
R	r/ℓ
X	x/ℓ



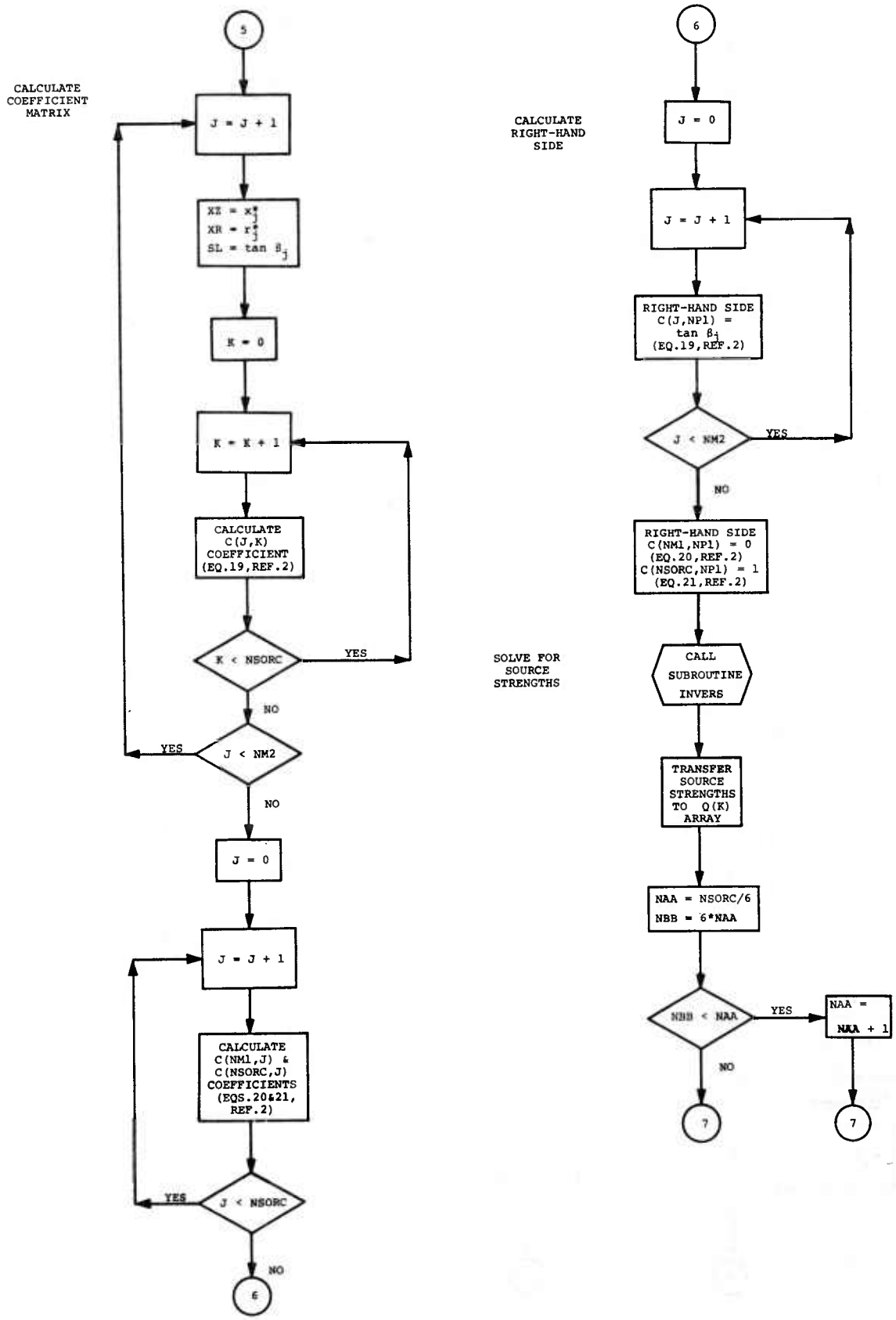
(a) Page 1.

Figure I-1.- Flow chart of source distribution program.



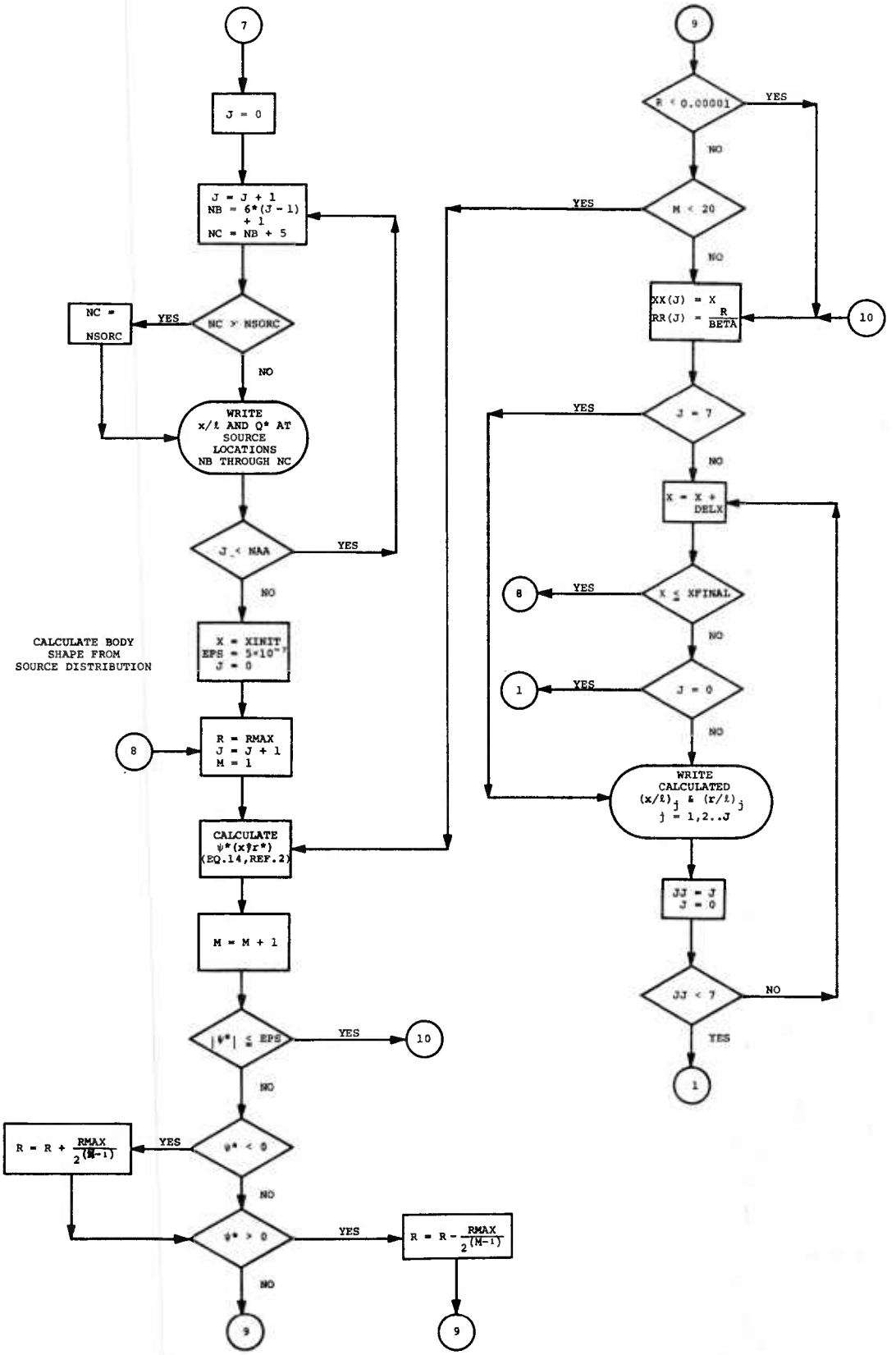
(b) Page 2.

Figure I-1.- Continued.



(c) Page 3.

Figure I-1.- Continued.



(d) Page 4.

Figure I-1.- Concluded.

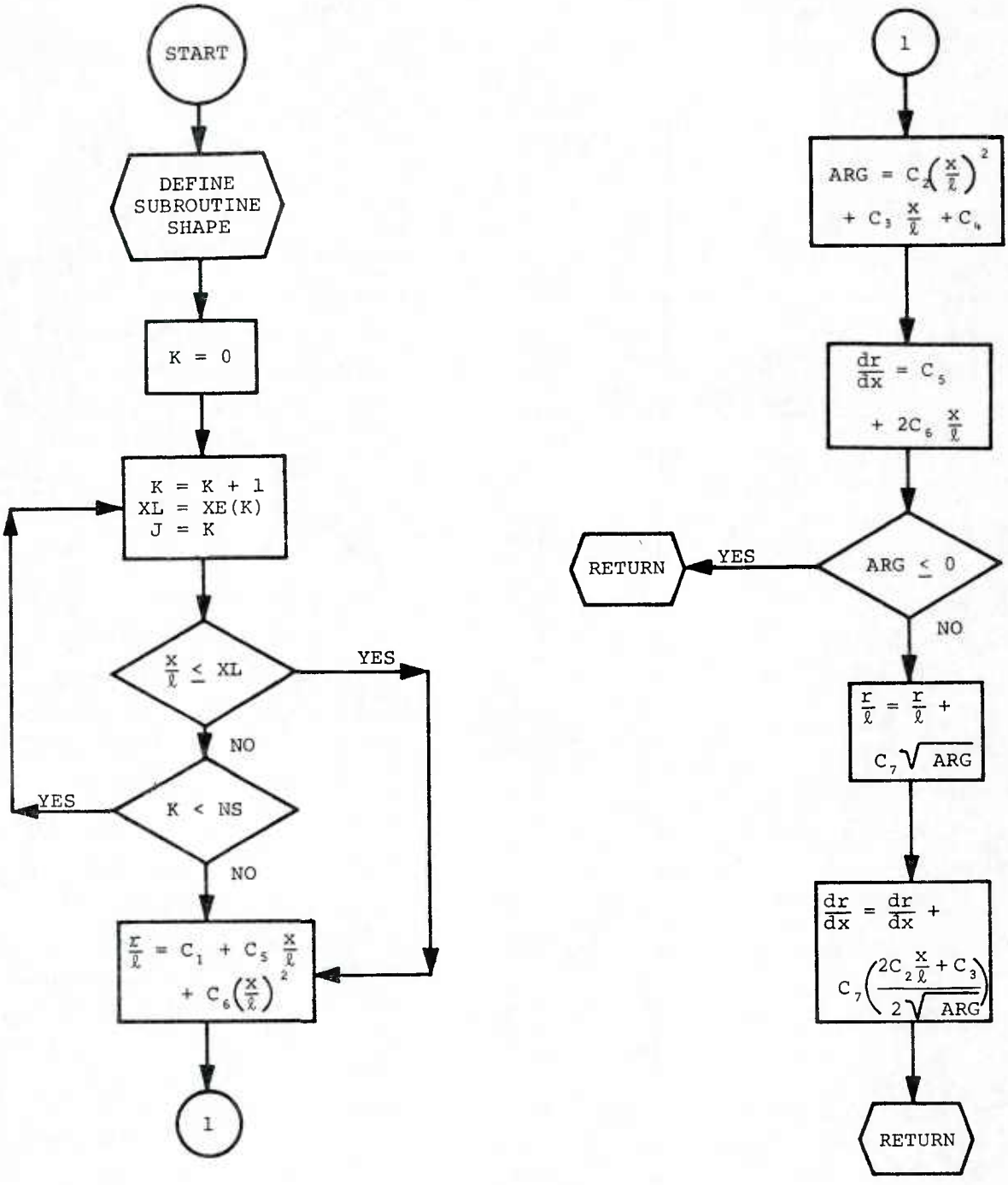


Figure I-2.- Flow chart of subroutine SHAPE.

APPENDIX II

DETAILS OF TRAJECTORY PROGRAM

II-1. INTRODUCTION

The purpose of this appendix is to provide more detailed information on the six-degree-of-freedom trajectory program which was described in section 4. A listing of the program was presented in figure 10 and a general flow chart in figure 11. This appendix will present more detailed flow charts and tables equating the program notation to the algebraic notation. The program consists of a main program and thirty-two subroutines. The main program will first be described and then the subroutines will be described in alphabetical order. The subroutines and their functions were listed in Table II.

II-2. MAIN PROGRAM

The first two pages of the flow chart which was presented in figure 11 are quite complete and will therefore not be expanded in this appendix. Using those pages, the description in section 4.1, the input data discussion in section 4.2.1, and the dictionary of notation in Table II-1, there should be sufficient information to understand the flow of the program.

The last page of the flow chart of figure 11 has been expanded and is presented in figure II-1. This portion of the program begins with card 6DA01419 on page 3 of the listing, figure 10(c), and is the integration loop of the program. The first step in the loop is to call subroutine FORCE to calculate the aerodynamic forces and moments acting on the store body. If the store has an empennage then subroutine EMPFOR is called to calculate the empennage forces and moments.

The next portion of the program solves for the translational and rotational accelerations. The set of six simultaneous equations which are solved are given in Appendix II of reference 1, equations (II-16) through (II-18) and (II-41) through (II-43). The coefficient matrix and right-hand side are stored in the FVN array. The first subscript of FVN is the equation number. The correspondence is

Subscript Value	Equation Number
1	II-16
2	II-17
3	II-18
4	II-41
5	II-42
6	II-43

The second subscript of FVN is the term in the equation. Here the correspondence is

Subscript Value	Term
1	$\ddot{\xi}$
2	$\ddot{\eta}$
3	$\ddot{\zeta}$
4	$\dot{p}$
5	$\dot{q}$
6	$\dot{r}$
7	Right-Hand Side

Thus, for example, FVN(3,5) is the coefficient of $\dot{q}$ in equation (II-18). Certain parts of this section of the program are bypassed if the store center of gravity, c.g., lies on the store moment center. If this is the case, $\bar{x},\bar{y}$ and $\bar{z}$ are zero and NASYM equals zero.

After calculating the coefficient matrix and right-hand side of the set of equations, subroutine INVERS is called to solve for the accelerations and the values are transferred to the DVAR array. The next steps of the program put the values of $\dot{\xi},\dot{\eta}$, and $\dot{\zeta}$ into the DVAR array and calculate the values of $\dot{\Psi},\dot{\Theta}$, and $\dot{\Phi}$, which are also put in the DVAR array. The DVAR array contains

DVAR(1)	$\ddot{\xi}$
DVAR(2)	$\ddot{\eta}$
DVAR(3)	$\ddot{\zeta}$
DVAR(4)	$\dot{p}$
DVAR(5)	$\dot{q}$
DVAR(6)	$\dot{r}$

DVAR(7)	$\dot{\xi}$
DVAR(8)	$\dot{\eta}$
DVAR(9)	$\dot{\zeta}$
DVAR(10)	$\dot{\Psi}$
DVAR(11)	$\dot{\Theta}$
DVAR(12)	$\dot{\Phi}$

These are the derivatives of the twelve dependent variables.

The program next checks to see if the integration procedure has reached the end of an integration step. If it has NOUT = 1 and subroutine OUTPUT is called to print the output. Next a check is made to see if the end of the trajectory has been reached, that is, is the current value of the time equal to the final time which was input. If it is then the program transfers to the first input statement and attempts to read another set of input data. If the end has not been reached, then the integration routine, subroutine ADAMS, is called.

NDIFEQ is a control index used by subroutine ADAMS. If NDIFEQ = 1 upon returning to the main program, an error condition has been encountered in ADAMS, the calculation is to be terminated, and the next set of input data is to be read. If $2 \leq$ NDIFEQ ≤ 7, the program is at some intermediate point in the integration from one point to the next. When NDIFEQ > 7, the integration of one step has been completed and NOUT is set equal to 1 so that the output subroutine will be called after the derivatives are calculated.

II-3. SUBROUTINE ADAMS

Subroutine ADAMS is the subroutine which integrates the set of differential equations. The subroutine will not be described in detail, however, an examination of the flow chart (fig. II-2) and the program listing (figs. 10(d) and 10(e)) will indicate how it functions. All returns from the subroutine are to the main program.

Consider the following set of n differential equations:

$$\dot{y}_1 = f_1(t, y_1, y_2, \ldots, y_n)$$
$$\vdots$$
$$\dot{y}_n = f_n(t, y_1, y_2, \ldots, y_n)$$

This subroutine uses a fourth-order Adams predictor-corrector method (ref. 6) to solve the above set of equations. To find the value of y_i at the $(J + 4)^{th}$ step, the following formula is used to predict the value

$$y^{(p)}_{i,j+4} = y_{i,j+3} + \frac{h}{24}\left(55\dot{y}_{i,j+3} - 59\dot{y}_{i,j+2} + 37\dot{y}_{i,j+1} - 9\dot{y}_{i,j}\right) \qquad \text{(II-1)}$$

This assumes that all of the $\dot{y}_i$'s are known for the j, $(j + 1)$, $(j + 2)$, and $(j + 3)$ steps. The quantity h is the interval in the independent variable between these points. After the values of the $y^{(p)}_{i,j+4}$ have been found, the following equation is used to obtain the corrected values:

$$y_{i,j+4} = y_{i,j+3} + \frac{h}{24}\left(9\dot{y}^{(p)}_{i,j+4} + 19\dot{y}_{i,j+3} - 5\dot{y}_{i,j+2} + \dot{y}_{i,j+1}\right) \qquad \text{(II-2)}$$

The use of the above equations require that four evenly spaced values of the dependent variables be known. These are found in this subroutine by means of a fourth-order Runge-Kutta method (ref. 6). To find the values of the y_i's at the $(j + 1)^{th}$ step, the following equation is used:

$$y_{i,j+1} = y_{i,j} + \frac{1}{6}\left(k_{i,1} + 2k_{i,2} + 2k_{i,3} + k_{i,4}\right) \qquad \text{(II-3)}$$

where

$$\left.\begin{aligned} k_{i,1} &= hf_i\left(t_j,\ x_{1,j},\ x_{2,j},\ \ldots,\ x_{n,j}\right) \\ k_{i,2} &= hf_i\left(t_j + \tfrac{1}{2}h,\ x_{1,j} + \tfrac{1}{2}k_{1,1},\ \ldots,\ x_{n,j} + \tfrac{1}{2}k_{n,1}\right) \\ k_{i,3} &= hf_i\left(t_j + \tfrac{1}{2}h,\ x_{1,j} + \tfrac{1}{2}k_{1,2},\ \ldots,\ x_{n,j} + \tfrac{1}{2}k_{n,2}\right) \\ k_{i,4} &= hf_i\left(t_j + h,\ x_{1,j} + k_{1,3},\ \ldots,\ x_{n,j} + k_{n,3}\right) \end{aligned}\right\} \qquad \text{(II-4)}$$

Thus, given initial values of the dependent variables, the y_i's, the independent variable, t, and the integration interval size, h, the differential equations are integrated three steps using equations (II-3) and (II-4). At this point, the integration is continued using equations (II-1) and (II-2).

A discussion of both the Adams and Runge-Kutta methods is presented in reference 6. From this reference, the truncation error, Δy, at a given

step can be shown to be

$$\Delta y = \left(\frac{y_{i,j+4} - y^{(p)}_{i,j+4}}{14.2} \right) \qquad \text{(II-5)}$$

so that the absolute error is

$$\Delta y_{ABS} = |\Delta y|$$

and the relative error is

$$\Delta y_{REL} = \frac{\Delta y_{ABS}}{|y_{i,j+4}|} \qquad \text{(II-6)}$$

At the end of each integration step, error tests are made in the following manner.

An upper bound for the relative error is specified. Then, each step, the relative error is compared against this bound for each $y_{i,j+4}$, $i = 1,2,\ldots,n$. If the test fails for some i, there exists the possibility that the absolute error has become so small as to be insignificant. Hence, the absolute error for this $y_{i,j+4}$ is then compared against a specified absolute error bound. If for any $y_{i,j+4}$, both of the above tests fail, the increment h is cut to $(1/2)h$, and the calculation restarts using the Runge-Kutta method with t_{j+3} as t_o.

If all error tests are "passed", the program tests whether the increment, h, being used is smaller than necessary. Since the error terms are roughly proportional to h^5, doubling the interval should increase the error by approximately 32 times. However, doubling the increment if the error terms are all less than 1/32 of their bounds would normally lead to oscillation in increment size and an inefficient program. In this program, if the relative error is less than 1/100 of the relative-error bound (or less than 1/100 of the absolute-error bound when the relative error test fails) for each $y_{i,j+4}$, the increment is doubled. The routine then restarts using the Runge-Kutta method with t_{j+4} as t_o and $2h$ as the increment.

At the start of the program, a special error procedure is used, since the calculations are done using the Runge-Kutta method. The $y_{i,2}$ is calculated using the increment $2h$. Then, $y_{i,1}$ and $y_{i,2}$ are calculated using the increment h. The absolute error is given in this case by:

$$\left| \frac{y_{i,2}^{(h)} - y_{i,2}^{(2h)}}{14.2} \right|$$

The relative- and absolute-error tests are then made as described above. If they fail, the increment is cut in half and the cycle repeated. No attempt is made to double the increment during Runge-Kutta cycles. If the tests are passed, $y_{i,3}$ is calculated by Runge-Kutta using the increment h, and successive values are then calculated by the Adams method.

The quantities in the parameter list are:

H	current value of the integration interval
DS	initial guess at integration interval
Y	array containing current values of the dependent variables
DY	array containing current values of the derivatives of the dependent variables
NEQ	number of equations being integrated; routine dimensioned for a maximum of 12
NDIFEQ	control index
S	current value of independent variable

II-4. SUBROUTINE CEL1

Subroutine CEL1 calculates the complete elliptic integral of the first kind. This subroutine has been taken directly from reference 7. For a description of the routine that reference should be consulted. A listing of the routine is presented in figures 10(e) and 10(f). The comment cards give a brief explanation of the use of the routine.

II-5. SUBROUTINE CEL2

Subroutine CEL2 calculates the complete elliptic integral of the second kind. This subroutine has been taken directly from reference 7. For a description of the routine that reference should be consulted. A listing of the routine is presented in figures 10(f) and 10(g). The comment cards give a brief explanation of the use of the routine.

II-6. SUBROUTINE DIRCOS

Subroutine DIRCOS computes the direction cosines which relate the store body coordinate system to the inertial coordinate system. The direction cosines are given by equation (28) of reference 1. A listing of the routine is presented in figure 19(g). The three angles Ψ,Θ, and Φ are brought into the subroutine in A(10), A(11), and A(12), respectively and the direction cosines are returned in the D array.

II-7. SUBROUTINE ELI1

Subroutine ELI1 calculates the general elliptic integral of the first kind. This subroutine has been taken directly from reference 7. For a description of the routine that reference should be consulted. A listing of the routine is presented in figure 10(g). The comment cards give a brief explanation of the use of the routine.

II-8. SUBROUTINE ELI2

Subroutine ELI2 calculates the general elliptic integral of the second kind. This subroutine has been taken directly from reference 7. For a description of the routine that reference should be consulted. A listing of the routine is presented in figures 10(g) and 10(h). The comment cards give a brief explanation of the use of the routine.

II-9. SUBROUTINE EMPFOR

Subroutine EMPFOR calculates the empennage forces and moments by the method described in section 5.3 and Appendix I of reference 1. A listing of the subroutine is presented in figures 10(h) and 10(i), a flow chart in figure II-3, and a table equating the algebraic and program notation in Table II-2 of this report.

An examination of the flow chart shows that the first steps in the routine are to locate the point at which the empennage forces act relative to the store moment center and to set JMAX equal to 2 or 4 depending on whether the empennage is planar or cruciform.

The next part of the subroutine calculates the perturbation velocity field at the MSF control points on each of the JMAX fins. At this point these velocities are in the fuselage, or inertial coordinate system. The

free-stream components are now added and the resulting velocities resolved into the store body coordinate system by subroutine INTOST. These velocities are made dimensionless by the store free-stream velocity and the pitch and yaw damping terms are added if aerodynamic damping is being included. From these velocities the components normal to the fin surfaces are determined. Positive directions are shown in figure 10 of reference 1.

The remainder of the routine calculates the empennage forces and moments. First W_o and V_o shown in figure 10 of reference 1 are determined from the velocity field used in the store body force and moment calculation. Then the normal force, and the side force if the empennage is cruciform, are calculated using equations (I-13) and (I-18) of reference 1. The spanwise integrations are performed using Simpson's rule. It is to be noted that in the present program all four fins are assumed to have the same span, $s_h = s_v$. The pitching moment and yawing moment are calculated using equations (I-21) and (I-22).

These forces and moments are in the fin coordinate system. They are resolved into the body coordinate system using equations (58) through (61) of reference 1.

Finally, if rolling moment is to be calculated this is done using equation (I-30) or (I-52) of reference 1. Equation (I-30) is for a planar empennage and (I-52) is for a cruciform empennage.

II-10. SUBROUTINE EMPINI

Subroutine EMPINI initializes certain quantities which will be used repeatedly in the empennage force and moment calculation, subroutine EMPFOR. The equations programmed are given in Appendix I of reference 1. A listing of the subroutine is presented in figures 10(i) and 10(j), a flow chart in figure II-4, and a table equating the algebraic and program notation in Table II-3 of this report.

The flow chart indicates that the first calculation performed is to determine the radial distance outward from the body axis to the MSF fin control points. The first point is at the body-fin juncture, $r_f = a$ (see fig. 10, ref. 1), and the last is at $a = s_h = s_v$. The others are equally spaced in between these two points. Next, a check is made to determine that XTAIL was input as a negative quantity and then the angular orientation of the fins in the store-body coordinate system is determined.

Referring to figure 10 of reference 1, these angles are measured in the clockwise direction from the z_s axis.

JMAX is next set equal to 2 or 4 depending on whether the empennage is planar or cruciform and then the y_s and z_s coordinates of the control points on all of the fins are determined. Next, certain constants are calculated and then the values of $(cc_\ell)_3$ are calculated at the control points. They are the same for all panels since $s_h = s_v$ (see eqs. (I-14) and (I-19), ref. 1).

If rolling moment is not to be calculated, NROLL = 0, control is returned to the calling program. If rolling moment is to be calculated, and the empennage is planar, IPLNR = 1, $(cc_\ell)_5$ given by equation (I-29) of reference 1 is calculated at the control points. Note that in the program the following substitution is made

$$\cosh^{-1}(x) = \ell n(x + \sqrt{x^2 + 1})$$

For a cruciform empennage, IPLNR = 0, equation (I-51) of reference 1 is used for the first control point where $y_f = a$. For the other control points equation (I-38) is used.

II-11. SUBROUTINE FORCE

Subroutine FORCE calculates the store-body forces and moments by the methods described in section 5.2 of reference 1. A listing of the subroutine is presented in figures 10(j) and 10(k), a flow chart in figure II-5, and a table equating the algebraic and program notation in Table II-4 of this report.

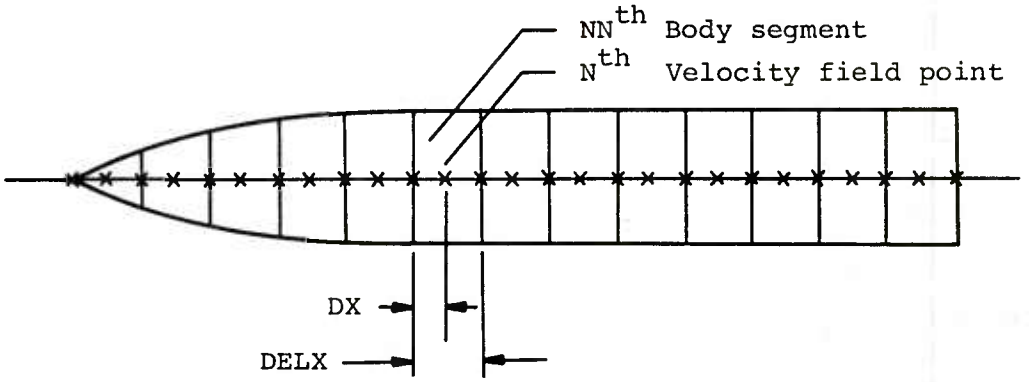
An examination of the flow chart shows that the first step in the routine is to check to see if the trajectory being calculated is to simulate a wind-tunnel captive-store trajectory. If it is, NGAM = 1, then the store attitude relative to the parent aircraft is changed. In wind-tunnel captive-store testing the yaw and pitch angles of the store are changed, only while measuring the aerodynamic forces and moments, to account for translational motion relative to the aircraft. The new angles are

$$\Psi_{cs} = \Psi_{ff} - \tan^{-1}\left(\frac{\dot{\eta}}{V_\infty \cos \alpha_f + \dot{\xi}}\right)$$

$$\theta_{cs} = \theta_{ff} + \tan^{-1}\left(\frac{\dot{\zeta}}{V_\infty \cos \alpha_f + \dot{\xi}}\right)$$

The subscript cs refers to captive store and ff refers to free flight. The direction cosines between this new body coordinate system and the inertial or fuselage system are calculated in DIRCOS. If the trajectory is a free-flight case, the direction cosines between the true body coordinate system and the inertial system are calculated.

The next section of the program calculates the velocity field given by equation (40) of reference 1 at specified points along the separated store longitudinal axis. The store is removed from the flow field during this calculation. One of the input parameters was NSEG which is the number of equal length segments the body is to be broken into. These segments are of length DELX as shown in the following sketch



The velocities are calculated at the midpoint of each segment as well as at the two ends, the points indicated by x in the sketch. There are thus NHSEG = 2*NSEG + 1 points. The perturbation velocity field is first calculated for all NHSEG points. These velocities are the u,v, and w components given by equation (37) of reference 1. The free-stream velocity components are next determined and added to the perturbation velocities given by equation (38). At this time the velocities are made dimensionless by V_{∞_s} and written in the x_s, y_s, z_s coordinate system. If damping is being included the damping terms in equation (40) are added.

The routine next calculates the forces and moments. The buoyancy forces and moments are first determined. From equations (42) and (44) of reference 1 the normal force and the pitching moment can be approximated by

$$(C_N)_{BY} = \sum_{N=2,4..}^{NHSEG-1} DELX\left(\frac{dC_N}{dx_s}\right)_N = \frac{2\pi}{S_R} \sum_{N=2,4..}^{NHSEG-1} DELX \left[a_N^2 \frac{\left(W^*_{s_{N+1}} - W^*_{s_{N-1}}\right)}{DELX} \right]$$

$$(C_m)_{BY} = \frac{1}{\ell_R} \sum_{N=2,4..}^{NHSEG-1} DELX \left[(x_{s,m} - x_s)\left(\frac{dC_N}{dx_s}\right)_N \right]$$

These are the equations which are programmed. Similar equations can be written for the side force and yawing moment.

Next the slender-body forces and moments are calculated. Referring to equations (46) and (48) of reference 1, the normal force and pitching moment are approximated by

$$(C_N)_{SB} = \sum_{N=2,4...}^{NHSEGO-1} DELX\left(\frac{dC_N}{dx_s}\right)_N = \frac{2\pi}{S_R} \sum_{N=2,4...}^{NHSEGO-1} DELX \frac{d}{dx_s} (a^2 W^*_s)_N$$

$$= \frac{2\pi}{S_R} \left\{ \sum_{N=2,4...}^{NHSEGO-1} DELX \left[a_N^2 \frac{\left(W^*_{s_{N+1}} - W^*_{s_{N-1}}\right)}{DELX} \right] + \sum_{N=2,4...}^{NHSEGO-1} DELX \left(a_N \frac{da_N}{dx_s} W^*_{s_N} \right) \right\}$$

$$(C_m)_{SB} = \frac{1}{\ell_R} \sum_{N=2,4...}^{NHSEGO-1} DELX \left[(x_{s,m} - x_s)\left(\frac{dC_N}{dx_s}\right)_N \right]$$

Here the summations are terminated at the assumed separation location as specified by NSEGXO of item 31 of the input data since NHSEGO = 2*NSEGXO+1. Note that the quantity in the first summation of $(C_N)_{SB}$ is the same as that in $(C_N)_{BY}$. Use has been made of this fact in the program. Similar expressions can be written for $(C_Y)_{SB}$ and $(C_n)_{SB}$.

If separation is assumed to occur ahead of the base of the store, NHSEGO < NHSEG, the viscous crossflow forces and moments in this region are calculated using equations (51) through (54) of reference 1. The normal force and pitching moment are approximated by

$$(C_N)_{CF} = \sum_{N=NHSEGO+1,+3..}^{NHSEG-1} DELX\left(\frac{dC_N}{dx_s}\right)_N = \frac{2c_{d_c}}{S_R} \sum_{N=NHSEGO+1,+3..}^{NHSEG-1} DELX\left(a_N V^*_{c_N} W^*_{s_N}\right)$$

$$(C_m)_{CF} = \frac{1}{\ell_R} \sum_{N=NHSEGO+1,+3..}^{NHSEG-1} DELX\left[(x_{s,m} - x_s)\left(\frac{dC_N}{dx_s}\right)_N\right]$$

II-12. SUBROUTINE INFWW

Subroutine INFWW calculates the influence coefficients of a horseshoe vortex as given by equations (10), (11), and (12) of section 4.2.2 of reference 1. The coordinate system and notation are shown in figure 2 of that reference. A listing of the subroutine is given in figures 10(k) and 10(l) of this report. A flow chart is not presented since the calculation is quite straightforward.

Referring to the listing and equations (10), (11), and (12)

$$F_u = FUI = FUONE$$

$$F_v = FVI = FVONE + FVTWO + FVTHRE$$

$$F_w = FWI = FWONE + FWTWO + FWTHRE$$

In terms of the notation in the equations and figure 2, the nine quantities in the subroutine parameter list are

PSII	$\tan \psi$
APHII	ϕ
XXX	x
YYY	y
ZZZ	z
SNN	s
FUI	F_u
FVI	F_v
FWI	F_w

II-13. SUBROUTINE INTOST

Subroutine INTOST (see fig. 10(l) for a listing) takes a vector with components specified in the inertial ξ,η,ζ coordinate system directions and transforms it into a vector with components in the store x,y,z coordinate system directions, see figure 9 of reference 1. That is,

$$\begin{bmatrix} s_x \\ s_y \\ s_z \end{bmatrix} = [A]' \begin{bmatrix} s_\xi \\ s_\eta \\ s_\zeta \end{bmatrix}$$

The matrix $[A]'$ is the transpose of the direction cosine matrix given by equation (II-2) of reference 1. The transpose is equal to the inverse since $[A]$ is orthogonal. The matrix $[A]$ was calculated in subroutine DIRCOS.

In terms of the above notation, the quantities in the parameter list of the subroutine are

XI	s_ξ
ETA	s_η
ZETA	s_ζ
X	s_x
Y	s_y
Z	s_z
DC	$[A]$

II-14. SUBROUTINE INVERS

For a discussion of subroutine INVERS see section I-3 of Appendix I of this report.

II-15. SUBROUTINE OUTPUT

Subroutine OUTPUT prints the output at the end of each integration step. A listing of the subroutine is presented in figures 10(l) and 10(m), a flow chart in figure II-6, and a table equating the algebraic and program notation in Table II-5 of this report.

The current value of the time is first printed and then the force and moment components calculated in subroutines FORCE and EMPFOR are summed up. The components and totals are then printed. Next the normal-force and side-force distributions and the velocity field along the store centerline are printed. The x_s locations are the midpoints of the body segments.

The next section of the subroutine locates the store nose, moment center, and base in the fuselage or inertial system. These points are located relative to the fuselage nose and also relative to where they would be had the store remained in the $t = 0$ position on the aircraft. These positions are printed.

The remainder of the subroutines prints the store moment center translational velocities and accelerations, the store rotational velocities and accelerations, and the store angular orientation and rates of change of these angles.

II-16. SUBROUTINE PTHIN

Subroutine PTHIN reads in the pylon thickness data and calculates certain quantities which characterize each of the pylon thickness source strips. The pylon thickness model is discussed in section 4.2.3 of reference 1 beginning at the bottom of page 17. The coordinate system and angle convention are shown in figure 6 of that reference. A listing of the subroutine is presented in figure 10(m), a flow chart in figure II-7, and a table equating the algebraic and program notation in Table II-6 of this report.

The number of strips in a chordwise row, NCPS, is first read in along with an index, NUNIP, which indicates whether the thickness distribution is similar at all spanwise stations. If it is similar, NUNIP = 1, the values of θ_p are read in for the first row and then the values of θ_p for the other rows are set equal to those of the first row. If the thickness distribution is not similar, NUNIP = 0, the values of θ_p for all rows are read in. The last step in this section of the subroutine applies the compressibility correction of section 3 of reference 1 to the values of θ_p.

The remainder of the subroutine calculates certain quantities associated with each thickness source strip which appear in equations (24)

through (26) of reference 1. These are

$$\Delta X_i \ , \ \tan \psi_i \ , \ X_{p_c} \ , \ \frac{\theta_p \Delta X_i \cos \psi_i}{2\pi}$$

The variables appearing in the subroutine parameter list are all defined in Table II-6.

II-17. SUBROUTINE PVLIN

Subroutine PVLIN reads in the pylon vortex-lattice data and calculates quantities from these data which locate and describe the horseshoe vortices. The vortex-lattice model is described in section 4.2.2 of reference 1. The coordinate system is shown in figure 2 of that reference. A listing of the subroutine is presented in figures 10(m) and 10(n), a flow chart in figure II-8, and a table equating the algebraic and program notation in Table II-7 of this report.

The first part of the subroutine reads data which are required to describe the pylon and to lay out the horseshoe vortices. It also applies the compressibility correction of section 3 of reference 1. The remainder of the subroutine calculates quantities associated with the horseshoe vortices and the control points. The bound leg of a vortex lies on the one-fourth-chord line of the area element. The X,Y,Z coordinates of the midspan of the bound leg are calculated as are the sweep of the bound leg and the semispan of the vortex. The control point lies at the midspan of the three-fourth-chord line of the area element. The X coordinate of this point is calculated as is the sweep of the three-fourth-chord line. The Y and Z coordinates of the control point are the same as for the bound-leg midpoint.

The variables appearing in the subroutine parameter list are all defined in Table II-7.

II-18. SUBROUTINE SHAPE

For a discussion of subroutine SHAPE see section I-4 of Appendix I of this report.

II-19. SUBROUTINE SIMSON

Subroutine SIMSON calculates the value of a definite integral using Simpson's rule. This can be found in any elementary numerical analysis book, for example, reference 8. As programmed here

$$I = \int_{x_o}^{x_o+m\Delta x} f(x)dx \cong \frac{\Delta x}{3}\Big[f(x_o) + 4f(x_o + \Delta x) + 2f(x_o + 2\Delta x) + 4f(x_o + 3\Delta x) + 2f(x_o + 4\Delta x) + \ldots + 4f(x_o + (m-1)\Delta x) + f(x_o + m\Delta x)\Big]$$

where m must be an even number and 4 or greater. The subroutine is listed in figure 10(n) of this report. Referring to the listing and the above equation, the quantities in the subroutine parameter list are

N	m + 1
F	f(x)
DX	Δx
SUM	I

II-20. SUBROUTINE SOROUT

Subroutine SOROUT prints a source distribution which has been read in for one of the axisymmetric bodies, the fuselage, rack, or a store. A listing of the subroutine is presented in figure 10(n). Eight x/ℓ source locations are written followed by the source strengths for these locations. This is repeated until the entire distribution has been printed. The quantities in the subroutine parameter list are

N	number of sources
X	source locations
S	source strengths

II-21. SUBROUTINE STRIO

Subroutine STRIO reads and prints the input data which describe and locate all of the stores and calculates the locations of the tips of the noses in the wing coordinate system. A listing of the subroutine is presented in figures 10(n) and 10(o), a flow chart in figure II-9, and a table equating the algebraic and program notation in Table II-8 of this report. The wing coordinate system is shown in figure 2 of reference 1.

The first loop in the subroutine reads in data for each store including a shape number, NSHAPE(J), and applies the compressibility correction of section 3 of reference 1. The input data are then printed. The next main loop of the routine reads in the source distributions and assigns the appropriate one to each of the stores. At the end of this loop a check is made to see if the index NCOUNT is equal to the number of stores, NSTRS. If it is not, source distributions have not been input for all of the shape numbers in the NSHAPE array. This causes the message "source distributions not input for all stores" to be printed and the program stops. The last part of the subroutine locates all of the stores in the wing coordinate system. Use is made of a number of quantities calculated in subroutine WVLIN.

The variables appearing in the subroutine parameter list are all defined in Table II-8 except for XBWOI and ZBWO. These two variables are not used and could be omitted here and in card 6DA01256 of the main program, see figure 10(b).

II-22. SUBROUTINE STTOIN

Subroutine STTOIN (see fig. 10(o) for a listing) takes a vector with components specified in the store x,y,z coordinate system directions and transforms it into a vector with components in the inertial ξ,η,ζ coordinate system directions, see figure 9 of reference 1. That is,

$$\begin{bmatrix} s_\xi \\ s_\eta \\ s_\zeta \end{bmatrix} = [A] \begin{bmatrix} s_x \\ s_y \\ s_z \end{bmatrix}$$

The matrix $[A]$ is given by equation (II-2) of reference 1 and was calculated in subroutine DIRCOS.

In terms of the above notation, the quantities in the parameter list of the subroutine are

X	s_x
Y	s_y
Z	s_z
XI	s_ξ
ETA	s_η
ZETA	s_ζ
DC	[A]

II-23. SUBROUTINE THOUT

Subroutine THOUT prints the slopes of the wing and pylon thickness distributions which were read in as items 16 and 21 of the input data, see section 4.2.1. A listing of the subroutine is presented in figure 10(o). The variables in the parameter list of the subroutine are

MS	number of wing thickness panels
THETAL	array containing values of θ in incompressible space (see fig. 5, ref. 1)
BETA	$\beta = \sqrt{1 - M_\infty^2}$
NCWS	number of thickness panels in a chordwise row on the wing
NPY	index indicating whether a pylon is (NPY = 1) or is not (NPY = 0) present
MPS	number of pylon thickness panels
THETPL	array containing values of θ_p in incompressible space (see fig. 6, ref. 1)
NCPS	number of thickness panels in a chordwise row on the pylon

It is to be noted that the values of θ and θ_p brought into the subroutine are in incompressible space. Before printing, they are transformed to compressible space and after printing returned to incompressible space. A sample of the output from this subroutine is shown in figure 20(e).

II-24. SUBROUTINE THPVEL

Subroutine THPVEL calculates the velocities induced at a field point X,Y,Z by the pylon thickness distribution using equation (25) of reference 1. This equation is for one thickness source panel and, therefore, must be summed over all panels to obtain the total perturbation velocity due to pylon thickness. A listing of the subroutine is presented in figures 10(o) and 10(p), a flow chart in figure II-10, and a table equating the algebraic and program notation in Table II-9.

The first three quantities in the subroutine parameter list, XC, YC, and ZC, are the coordinates of the point X,Y,Z at which the velocities are to be calculated. The variables UP, VP, and WP are the u/V_∞, v/V_∞, and w/V_∞ perturbation velocities due to the wing-pylon vortex-lattice model and the wing and pylon thickness distributions. On entry into the subroutine they are the values excluding pylon thickness. Just before return to the calling program these velocities are added. The last quantity in the subroutine parameter list, JC, is not used.

The subroutine is basically a double loop which sums equation (25) of reference 1 over all of the thickness source strips. The outer loop sums over the span and the inner loop over the chord at a given spanwise location. The only part of the routine requiring explanation is that which begins with card 6DA23 31 and ends with card 6DA23 37. Figure 6 of reference 1 shows a line swept at an angle λ_{p_i} with respect to the Z direction. This line lies at the 50-percent chord of the source strip. If the point at which the velocities are to be calculated lies on the extension of this line then a limiting form of equation (25) must be used. This situation exists if

$$\frac{Z - Z_a}{F} \cong 1.0$$

where F is given by equation (26) of reference 1. The limiting form of equation (25) is

$$\frac{\Delta u}{V_\infty} = \frac{\theta_p \Delta X_i}{2\pi} \cos \psi_i \sin \psi_i \left(\frac{1}{Z - Z_b} - \frac{1}{Z - Z_a} \right)$$

$$\frac{\Delta v}{V_\infty} = 0$$

$$\frac{\Delta w}{V_\infty} = \frac{\theta_p \Delta X_i}{2\pi} \cos^2 \psi_i \left(\frac{1}{Z - Z_b} - \frac{1}{Z - Z_a} \right)$$

II-25. SUBROUTINE THWVEL

Subroutine THWVEL calculates the velocities induced at a field point X,Y,Z by the wing thickness distribution using equation (19) of reference 1. This equation is for one thickness source panel and, therefore, must be summed over all panels to obtain the total perturbation velocity due to wing thickness. A listing of the subroutine is presented in figure 10(p), a flow chart in figure II-11, and a table equating the algebraic and program notation in Table II-10.

The first three quantities in the subroutine parameter list, XC, YC, and ZC, are the coordinates of the point X,Y,Z at which the velocities are to be calculated. The variables UW, VW, and WW are the u/V_∞, v/V_∞, and w/V_∞ perturbation velocities due to the wing-pylon vortex-lattice model and the wing thickness distribution. On entry into the subroutine they are the values excluding wing thickness. Just before return to the calling program these velocities are added. The last quantity in the subroutine parameter list, JC, is not used.

The subroutine is basically a double loop which sums equation (19) of reference 1 over all of the thickness source strips. The outer loop sums over the span and the inner loop over the chord at a given spanwise location. Inside this loop is another loop with the index LSIDE. When LSIDE = 1, the velocities due to the i^{th} source strip on the left wing panel are calculated. When LSIDE = 2, the velocities due to the corresponding strip on the right wing panel are calculated. Since all of the quantities describing the strips are for the left panel, the signs on Y_a, Y_b, $\tan \psi_i$, and $\cos \psi_i$ are changed for the right panel, see section 4.2.3 of reference 1 for a further discussion of this. Upon exiting from the LSIDE loop the signs are returned to their original condition.

II-26. SUBROUTINE VELFLD

Subroutine VELFLD, along with other subroutines which it calls, calculates the perturbation velocities at a point on the separated store due to all the other aircraft components. A listing of the subroutine is presented in figures 10(p) and 10(q), a flow chart in figure II-12, and a table equating the algebraic and program notation in Table II-11 of this report. The quantities in the parameter list of the subroutine are defined in this table.

If there is a fuselage (NFU = 1) the subroutine calls subroutine VELOC to calculate the perturbation velocities produced by the source distribution which models the fuselage volume. Next, two checks are made. The first determines whether the wing is near the bottom of the fuselage and the second determines whether the y_B coordinate of the field point is greater than the fuselage radius. If either of these tests are passed control transfers to the wing-pylon flow field calculation. If both fail, the fuselage angle-of-attack induced velocity is calculated using equation (39) of reference 1 and if there is no pylon (NPY = 0) or the pylon is not under the fuselage centerline the wing-pylon calculation is bypassed. If there is a pylon under the centerline NCON is set equal to 2.

The next section of the subroutine calculates the wing-pylon induced velocities. The field point at which the velocities are to be calculated is located in the wing coordinate system, the X,Y,Z system of figure 5 of reference 1, and then subroutine VLIVEL is called to calculate the wing-pylon induced velocities. Upon return from the subroutine the perturbation velocities UF, VF, and WF are in directions parallel to X,Y, and Z. These velocities are resolved into the fuselage coordinate system and added to the fuselage induced perturbation velocities.

In a similar manner the perturbation velocities due to the rack, if one is present, and all other stores present, if any, are added in. In all cases the field point is first located in the coordinate system of the body in question, the velocities calculated in subroutine VELOC, and then resolved into the fuselage system as they are added up.

The perturbation velocities have been summed up in the fuselage system since this is the coordinate system to which the compressibility correction was applied, see section 3 of reference 1. The velocities are

now transformed to the compressible fuselage coordinate system using equation (2) of that reference. Subroutine INTOST is called to resolve the velocities into the separated store coordinate system, the x,y,z system shown in figures 8 and 9 of reference 1. The fuselage system is the ξ,η,ζ system shown in figure 9.

II-27. SUBROUTINE VELOC

Subroutine VELOC calculates the perturbation velocities induced at a field point of an axisymmetric body by the source distribution which represents its volume. A listing of the subroutine is presented in figure 10(q) and a flow chart in figure II-13 of this report. The coordinate system is shown in figure 1 of reference 1. The algebraic notation is defined in the list of symbols of that reference.

The quantities in the subroutine parameter list are:

X,Y,Z	x,y,z coordinates of the field point
XS	array containing the x_k locations of the N sources
SS	array containing the strengths, $Q_k/4\pi V_\infty$, of the N sources
NS	N, number of sources
U,V,W	u/V_∞, v/V_∞, and w/V_∞ perturbation velocities; positive in the x,y,z directions, respectively
RMAX	maximum radius of axisymmetric body

At the beginning of the subroutine the radial location, r, of the field point measured perpendicular to the x axis is calculated and the u/V_∞ perturbation velocity is set to zero. If the number of sources, NS, is zero, v/V_∞ and w/V_∞ are set to zero and control returns to the calling program. If this is not the case the radial perturbation velocity, v_r/V_∞, is set to zero and r is compared with RMAX. If r is less than or equal to RMAX, the possibility exists that the field point lies inside the body. To determine whether or not this is the case, the value of the stream function ψ/V_∞ (called PSI in the subroutine) is calculated using the following equation

$$\frac{\psi(x,r)}{V_\infty} = \frac{1}{2} r^2 - \sum_{k=1}^{N} \frac{Q_k}{4\pi V_\infty} \left\{ 1 - \frac{(x - x_k)}{\left[(x - x_k)^2 + r^2\right]^{1/2}} \right\}$$

If the value of ψ/V_∞ is negative then the field point is inside the body and if $\psi/V_\infty = 0$ then the point lies on the body surface. For either of these situations v/V_∞ and w/V_∞ are set to zero and control returns to the calling program.

If the field point lies outside the body, the u/V_∞ and v_r/V_∞ perturbation velocities are calculated using the following equations

$$\frac{u(x,r)}{V_\infty} = \sum_{k=1}^{N} \frac{Q_k}{4\pi V_\infty} \frac{(x - x_k)}{\left[(x - x_k)^2 + r^2\right]^{3/2}}$$

$$\frac{v_r(x,r)}{V_\infty} = \sum_{k=1}^{N} \frac{Q_k}{4\pi V_\infty} \frac{r}{\left[(x - x_k)^2 + r^2\right]^{3/2}}$$

The remainder of the subroutine resolves v_r/V_∞ into components in the y and z directions. In doing this the signs of v/V_∞ and w/V_∞ are adjusted to reflect the quadrant of the y-z plane in which the field point is located.

II-28. SUBROUTINE VLCOEF

Subroutine VLCOEF calculates the coefficient matrix of the set of simultaneous equations which are to be solved to determine the strengths of the vortices in the wing-pylon vortex-lattice model, see section 4.2.2 of reference 1. These coefficients are the multipliers of $\Gamma_n/4\pi V_\infty$ in equations (6) and (7) of reference 1. A listing of the subroutine is presented in figures 10(q) and 10(r), a flow chart in figure II-14, and a table equating the algebraic and program notation in Table II-12 of this report. The quantities in the parameter list of the subroutine are defined in this table.

The subroutine consists of four double DO loops. The first double loop, the 212 loop, calculates the coefficients of the first summation on the left-hand side of equation (6). The second loop, the 312 loop,

calculates the coefficients of the second summation. The remaining two loops, 412 and 512, calculate the coefficients of the two summations in equation (7). If there is no pylon (NPY = 0) or if the pylon is under the fuselage centerline (IP = 1), the last three loops are bypassed.

All four loops calculate the coefficients in the same manner. The ν^{th} control point is first located with respect to the coordinate system of the n^{th} vortex on the left wing panel or pylon and also with respect to the coordinate system of the image vortex on the right wing panel or pylon. Then subroutine INFWW is called twice to calculate the values of F_u, F_v, and F_w due to these two vortices. Prior to calling INFWW the second time the signs of the sweep and dihedral angles are changed for the reasons discussed on page 14 of reference 1. After this second calculation the signs are returned to the original condition. With these values of F_u, F_v, and F_w determined, the coefficient is then calculated.

II-29. SUBROUTINE VLIVEL

Subroutine VLIVEL calculates the perturbation velocities at a field point due to the wing-pylon vortex-lattice model and wing and pylon thickness. The methods used are described in sections 4.2.2 and 4.2.3 of reference 1. A listing of the subroutine is presented in figure 10(r), a flow chart in figure II-15, and a table equating the algebraic and program notation in Table II-13 of this report. The quantities in the parameter list of the subroutine are defined in this table.

At the beginning of the subroutine the three variables, UI, VI, and WI, which return the incompressible wing-pylon perturbation velocities to the calling program, are set to zero. A check is next made on the value of the index NCON. If it is equal to two only pylon thickness velocities are to be calculated. Subroutine THPVEL is called for this purpose.

If NCON is not equal to two, the velocities induced at the field point by the wing vortex lattice are first calculated. These velocities are given by equations (8) through (14) in reference 1. The field point is first located with respect to the coordinate system of the n^{th} vortex on the left wing panel and also with respect to the coordinate system of the image vortex on the right wing panel. Then subroutine INFWW is called twice to calculate the values of F_u, F_v, and F_w due to these two vortices. Prior to calling INFWW the second time the signs of the sweep

and dihedral angles are changed for the reasons discussed on page 14 of reference 1. After this second calculation the signs are returned to the original condition. With these values of F_u, F_v, and F_w determined, the velocities are calculated using equation (8). The value of Γ_n/V_∞ is contained in the CIR array. These velocities are calculated and summed up for all M wing vortices.

The next loop in the program calculates the velocities due to the pylon vortex lattice in an identical manner. This calculation is not performed when NCP equals zero. This is the case when there is no pylon.

The remainder of the subroutine calls subroutines THWVEL and THPVEL to calculate the velocities induced by the wing and pylon thickness distributions. If NCP equals zero the pylon calculation is bypassed since there is no pylon.

II-30. SUBROUTINE VLOUT

Subroutine VLOUT prints the coordinates of the wing-pylon vortex-lattice control points and the wing twist and camber distribution which was read in. These quantities are for the actual wing-pylon combination, not the equivalent incompressible one, and are in the wing coordinate system shown in figure 14 of this report. A sample of the output produced by this subroutine is shown in figure 20(d). A listing of the subroutine is presented in figure 10(s).

The variables in the subroutine parameter list are:

M	number of wing vortices
NCW	number of wing vortices in a chordwise row; input, item 11
BETA	$\beta = \sqrt{1 - M_\infty^2}$
PCX,PVY, PVZ	arrays containing the x,y,z coordinates of the wing control points in incompressible space in wing coordinate system
ALPHAL	array containing the input twist and camber distribution; input, item 14
NPY	index indicating whether a pylon is (NPY = 1) or is not (NPY = 0) present; input, item 4
MP1	M + 1

MMP	M + MP where MP is the number of pylon vortices
NCP	number of pylon vortices in a chordwise row; input, item 18
PCPX,PVPY, PVPZ	arrays containing the x,y,z coordinates of the pylon control points in incompressible space in wing coordinate system

It is noted that the x coordinates of the control points are transformed to compressible space, using equation (1) of reference 1, before printing.

II-31. SUBROUTINE VLRHS

Subroutine VLRHS calculates the right-hand-side vector of the set of simultaneous equations, equations (6) and (7) of reference 1, which are to be solved to determine the strengths of the vortices in the wing-pylon vortex-lattice model, see section 4.2.2 of reference 1. A listing of the subroutine is presented in figures 10(s) and 10(t), a flow chart in figure II-16, and a table equating the algebraic and program notation in Table II-14 of this report. The quantities in the parameter list of the subroutine are defined in this table.

The major portion of this routine is devoted to evaluating the externally induced perturbation velocities, $u_{i,\nu}$, $v_{i,\nu}$, and $w_{i,\nu}$, at all of the wing-pylon control points.

The first section calculates the fuselage induced velocities if a fuselage is present (NFU = 1). The velocities induced at the wing control points are not calculated if the wing lies in the fuselage x-y plane. If the velocities are to be calculated, the control point associated with an area element is located in the fuselage coordinate system (see fig. 13) and subroutine VELOC is called to calculate the velocities at this point. These velocities are next resolved into the wing coordinate system and added to the UEI, VEI, and WEI arrays. This is repeated for all M control points. If there is a pylon, NPY = 1, and the pylon is not under the fuselage centerline, IP > 1, the same procedure is followed for the MP pylon control points. If the pylon is below the fuselage centerline, the calculation is not performed since only the lateral, v_i, velocity appears in the boundary condition (see eq. (7), ref. 1). In the y_B equal zero plane v_i due to the fuselage is zero.

The next loop in the subroutine repeats the calculation for the ejector rack if one is present, NRACK = 1. Only velocities induced by the rack at the wing control points are calculated. The rack is assumed to be immediately below the pylon and thus induces no lateral velocity at the pylon control points.

The perturbation velocities induced by all of the stores are next calculated in the same manner as for the fuselage and rack. In this calculation, velocities induced by the stores at the pylon control points are not calculated when the pylon is located below the fuselage centerline, IP = 1. The fuselage $x_B - z_B$ plane is a vertical plane of symmetry and thus any stores on one side of this plane are assumed to have images on the other side of the plane. The lateral velocities induced would thus be equal and opposite in sign and cancel each other.

If a pylon is present, NPY = 1, its thickness distribution produces perturbation velocities at the wing control points. Subroutine THPVEL is next called for each of the M wing control points for the purpose of calculating these velocities and adding them to the UEI, VEI, and WEI arrays. Similarly, subroutine THWVEL is called to calculate the wing thickness perturbation velocities at the MP pylon control points. This calculation is bypassed when the pylon is below the fuselage centerline since the net lateral velocity due to the two wing panels is zero in the $x_B - z_B$ plane.

The last two loops in the subroutine calculate the right-hand sides of equations (6) and (7) of reference 1. Note that these equations have been multiplied by 4π, thus the factor 12.566371 in the subroutine.

II-32. SUBROUTINE VSTOUT

Subroutine VSTOUT prints the coordinates of the wing-pylon vortex-lattice control points, the perturbation velocities induced at these points by all of the other aircraft components (these were calculated in subroutine VLRHS), and the vortex strengths which were determined by solving the set of simultaneous equations given by equations (6) and (7) of reference 1. The quantities brought into the subroutine are in incompressibile space. Therefore, the compressibility correction of section 3 of reference 1 is applied just before printing so that the compressible values are tabulated. A sample of the output produced by this subroutine

is shown in figure 20(g) of this report. The wing coordinate system is shown in figure 14 and a listing of the subroutine is presented in figure 10(t).

The variables in the subroutine parameter list are:

M	number of wing vortices
NCW	number of wing vortices in a chordwise row; input, item 11
BETA	$\beta = \sqrt{1 - M_\infty^2}$
BETASQ	β^2
UEI,VEI, WEI	arrays containing incompressible perturbation velocities at the wing-pylon vortex-lattice control points; u_i/V_∞, v_i/V_∞, and w_i/V_∞ appearing in equations (6) and (7) of reference 1
CIR	array containing the incompressible vortex strengths; Γ_n/V_∞ in equations (6) and (7) of reference 1
PCX,PVY, PVZ	arrays containing the x,y,z coordinates of the wing control points in incompressible space in wing coordinate system
NPY	index indicating whether a pylon is (NPY = 1) or is not (NPY = 0) present; input, item 4
MP1	M + 1
MMP	M + MP where MP is the number of pylon vortices
NCP	number of pylon vortices in a chordwise row; input, item 18
PCPX,PVPY, PVPZ	arrays containing the x,y,z coordinates of the pylon control points in incompressible space in wing coordinate system

II-33. SUBROUTINE WTHIN

Subroutine WTHIN reads in the wing thickness data and calculates certain quantities which characterize each of the wing thickness source strips. The wing thickness model is discussed in section 4.2.3 of reference 1. The coordinate system and angle convention are shown in figure 5 of that reference. A listing of the subroutine is presented in figure 10(t), a flow chart in figure II-17, and a table equating the algebraic and program notation in Table II-15 of this report.

The number of strips in a chordwise row, NCWS, is first read in along with an index, NUNIS, which indicates whether the thickness distribution is similar at all spanwise stations. If it is similar, NUNIS = 1, the values of θ are read in for the first row and then the values of θ for the other rows are set equal to those of the first row. If the thickness distribution is not similar, NUNIS = 0, the values of θ for all rows are read in. The last step in this section of the subroutine applies the compressibility correction of section 3 of reference 1 to the values of θ.

The remainder of the subroutine calculates certain quantities associated with each thickness source strip which appear in equations (18) through (20) of reference 1. These are

$$\Delta X_i \ , \ \tan \psi_i \ , \ X_c \ , \ Z_1 \ , \ \frac{\theta \Delta X_i \cos \psi_i}{2\pi}$$

The variables appearing in the subroutine parameter list are all defined in Table II-15.

II-34. SUBROUTINE WVLIN

Subroutine WVLIN reads in the wing vortex-lattice data and calculates quantities from these data which locate and describe the horseshoe vortices. The vortex-lattice model is described in section 4.2.2 of reference 1. The coordinate system is shown in figure 2 of that reference. A listing of the subroutine is presented in figure 10(u), a flow chart in figure II-18, and a table equating the algebraic and program notation in Table II-16 of this report. All of the quantities appearing in the subroutine parameter list are defined in this table.

The first part of the subroutine reads data which are required to describe the wing and to lay out the horseshoe vortices. Next the wing twist and camber distribution, if any, is read. Two indices, NTAC and NUNI, are first input. If NTAC = 0 there is no twist and camber. The index NUNI indicates whether the twist and camber distribution is similar at all spanwise stations. If it is similar, NUNI = 1, the values of $\tan \alpha_\ell$ are read in for the first row and then the values of $\tan \alpha_\ell$ for the other rows are set equal to those of the first row. If the thickness distribution is not similar, NUNI = 0, the values of $\tan \alpha_\ell$ for all rows are read in. Following this the compressibility correction of section 3

of reference 1 is applied to the wing root chord, leading- and trailing-edge sweep angles, and twist and camber distribution.

The remainder of the subroutine calculates quantities which describe the wing segments, the horseshoe vortices, and the control points. This is done in a double DO loop. The quantities associated with the wing segment are calculated in the outer loop and are the X,Y,Z coordinates, the dihedral angle, and the local chord at the midspan and the left-hand side. In the inner loop, quantities describing each wing area element and associated horseshoe vortex are calculated. The first quantities calculated are the planform plane sweep angles of the 1/4 and 3/4 chord lines of the area element, the dihedral angle, the chordal plane 1/4 chord sweep angle, and the chordal plane semispan. The bound leg of a vortex lies on the 1/4 chord line of the area element. The X,Y,Z coordinates of the midspan of the bound leg are next calculated. The control point lies at the midspan of the 3/4 chord line of the area element. The X coordinate of this point is calculated. The Y and Z coordinates of the control point are the same as for the bound-leg midpoint. The last three quantities calculated in the loop are the X,Y,Z coordinates of the intersection of the 3/4 chord line with the left, or outboard side, of the area element.

Just before returning to the calling program, the span and average chord of the incompressible wing are calculated.

TABLE II-1

DICTIONARY OF NOTATION IN MAIN PROGRAM

The following list presents most of the variable names used in the main program. Those which appear in parameter lists of subroutines but are not used in the main program are not included. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Primes associated with the algebraic notation indicate incompressible space (see section 3 of ref. 1). The x_B, y_B, z_B coordinate system is shown in figure 13 of this report.

PROGRAM NOTATION	ALGEBRAIC NOTATION
ACCG	g, 32.174 feet/second
ALFAC	α_f, degrees; input, item 3
ALFACR	α_f, radians
ALFAI	α_f', degrees
ALFAIR	α_f', radians
ALFWIR	angle of attack of wing in incompressible space, rad.
BETA	β
CA	C_A; input, item 36
CAPG	$\cos(\alpha_f + \gamma_f)$
CDC	c_{d_c}; input, item 36
CIR(N)	Γ_n'/V_∞
CLALPH	lift-curve slope of tail panels; input, item 38
CLLEM	$(C_\ell)_E$, equations (62) and (I-30) or equations (63) and (I-52)
CLMBY	$(C_m)_{BY}$, equation (44)
CLMCF	$(C_m)_{CF}$, equation (53)

Table II-1.- Continued.

CLMEM	$(C_m)_E$, equation (60)
CLMSB	$(C_m)_{SB}$, equation (48)
CLNBY	$(C_n)_{BY}$, equation (45)
CLNCF	$(C_n)_{CF}$, equation (54)
CLNEM	$(C_n)_E$, equation (61)
CLNSB	$(C_n)_{SB}$, equation (49)
CNBY	$(C_N)_{BY}$, equation (42)
CNCF	$(C_N)_{CF}$, equation (51)
CNEM	$(C_N)_E$, equation (58)
CNORM	total C_N
CNSB	$(C_N)_{SB}$, equation (46)
COEF(I,J)	coefficients of polynomials specifying separated store shape; input, item 35
COSSPS(I)	cos ψ_i for a pylon thickness panel
COSSWS(I)	cos ψ_i for a wing thickness panel
CPITCH	total C_m
CRIIR	cos(RIIR)
CROLL	total C_ℓ
CSIBCR(N)	cos(SIBCR(N))
CSIBIR(N)	cos(SIBIR(N))
CSIDE	total C_Y
CSIIR(N)	cos(SIIR(N))
CWICR	cos(WICR)
CWIIR	cos(WIIR)
CYAW	total C_n
CYBY	$(C_Y)_{BY}$, equation (43)
CYCF	$(C_Y)_{CF}$, equation (52)

Table II-1.- Continued.

CYEM	$(C_Y)_E$, equation (59)
CYSB	$(C_Y)_{SB}$, equation (47)
DC(I,J)	[A], equation (28)
DDTIME	input value of integration interval; set equal to DTIME of item 40
DELX	length of body segment used in force calculation
DELXI	DELX in incompressible space
DTIME	current value of integration interval
DTR	degrees to radians conversion factor, 1/57.29578
DVAR(N), N = 1,2,...12	$\ddot{\xi},\ddot{\eta},\ddot{\zeta},\dot{p},\dot{q},\dot{r},\dot{\xi},\dot{\eta},\dot{\zeta},\dot{\Psi},\dot{\Theta},\dot{\Phi}$ respectively
EDRDX(I)	da/dx_s at the midpoint of the i^{th} segment of the separated store
ERAD(I)	a at the midpoint of the i^{th} segment of the separated store
ESTLGC	ℓ_s of separated store
ESTLGI	ℓ_s' of separated store
ESTRMX	a_{max} of separated store
EXST(I)	x_s location of the i^{th} half segment on the separated store
FINSS	tail fin semispan; input, item 38
FIXX	I_{xx}
FIXY	I_{xy}
FIXZ	I_{xz}
FIYY	I_{yy}
FIYZ	I_{yz}
FIZZ	I_{zz}
FLTHC	fuselage length; input, item 5
FLTHI	fuselage length in incompressible space

Table II-1.- Continued.

FMACH	M_∞; input, item 3
FRMAX	fuselage maximum radius; input, item 5
FSOR(N)	array containing the strengths of the fuselage source distribution
FXL(N)	array containing the x'_B positions of the fuselage sources
GAMF	fuselage flight path angle, γ_f; input, item 3
GXX,GYY,GZZ	g_x, g_y, g_z, equation (67)
IP	pylon location specification; input, item 17
IPLNR	empennage type; input, item 37
M	number of vortices on wing, M = NCW*MSW
MMP	M + MP
MP	number of vortices on pylon, MP = NCP*MSP
MPS	number of pylon thickness panels, MPS = NCPS*MSP
MP1	M + 1
MS	number of wing thickness panels, MS = NCWS*MSW
MSF	input, item 37
MSP	input, item 18
MSW	input, item 11
NCP	input, item 18
NCPS	input, item 20
NCW	input, item 11
NCWS	input, item 15
NDAMP	input, item 31
NDIFEQ	control index used in subroutine ADAMS
NEJECT	number of store being separated; input, item 31
NEJSTR	subscript associated with separated store, $1 \leq$ NEJSTR $\leq$ NSTRS

Table II-1.- Continued.

NEMP	input, item 31
NEQ	number of differential equations being integrated by subroutine ADAMS; NEQ = 12
NFSOR	number of fuselage sources; input, item 6
NFU	input, item 4
NGAM	input, item 31
NHSEG	number of points along store axis where velocity field is to be calculated; NHSEG = 2*NSEG + 1
NHSEGO	number of points along store axis ahead of separation point where velocity field is to be calculated; NHSEGO = 2*NSEGXO + 1
NPOLY	input, item 31
NPY	input, item 4
NRACK	input, item 4
NROLL	input, item 31
NRSOR	number of rack sources; input, item 23
NSEG	input, item 31
NSEGXO	input, item 31
NSTRS	input, item 4
NUMSTR(I)	number associated with i^{th} store; input, item 26
PI	π , 3.1415927
PHIROL	fin orientation; input, item 38
QSREF	$q_{\infty_S} S_R$
QSREFL	$q_{\infty_S} S_R \ell_R$
QSTORE	q_{∞_S}, equation (69)
RAD	radians to degrees conversion factor, 57.29578
RADAV	average body radius in fin region; input, item 38
REFL	ℓ_R, equation (72)

Table II-1.- Continued.

RHO	ρ_∞; input, item 3
RIC	rack incidence angle; input, item 22
RII	rack incidence angle in incompressible space, degrees
RIIR	rack incidence angle in incompressible space, radians
RLTHC	rack length; input, item 22
RLTHI	rack length in incompressible space
RRMAX	maximum rack radius; input, item 22
RSOR(N)	array containing the strengths of the rack source distribution
RXL(N)	array containing the axial locations of the rack sources
SAPG	$\sin(\alpha_f + \gamma_f)$
SIBCR(I)	incidence angle of i^{th} store relative to fuselage axis, radians; (WIC + SIC(I))*DTR
SIBIR(I)	incidence angle of i^{th} store relative to fuselage axis in incompressible space; radians; WIIR + SIIR(I)
SIC(I)	incidence angle of the i^{th} store; input, item 26
SII(I)	incidence angle of i^{th} store relative to wing root-chord in incompressible space, degrees
SIIR(I)	incidence angle of i^{th} store relative to wing root-chord in incompressible space, radians
SINSPS(I)	$\sin \psi_i$ for a pylon thickness panel
SINSWS(I)	$\sin \psi_i$ for a wing thickness panel
SLTHC(I)	length of i^{th} store; input, item 26
SLTHI(I)	length of i^{th} store in incompressible space
SMASS	m, mass of separated store; input, item 32
SREF	S_R, equation (70)
SRMAX(I)	maximum radius of i^{th} store
SSIBCR(I)	sin(SIBCR(I))
SSIBIR(I)	sin(SIBIR(I))

Table II-1.- Continued.

SSIIR(I)	sin(SIIR(I))
SWICR	sin(WICR)
SWIIR	sin(WIIR)
TIME	t, current value of time
TIMEF	final time; input, item 40
TIMEI	initial time; input, item 40
UU	$\dot{x}_o$
VAR(N), N = 1,2,...12	$\dot{\xi},\dot{\eta},\dot{\zeta},p,q,r,\xi,\eta,\zeta,\Psi,\theta,\Phi$ respectively
VINF	V_∞; input, item 3
VSTORE	V_{∞_S}, equation (41)
VZERO	input, item 39
WIC	wing incidence angle, degrees; input, item 9
WICR	wing incidence angle, radians
WII	wing incidence angle in incompressible space, degrees
WIIR	wing incidence angle in incompressible space, radians
WW	$\dot{z}_o$
XBAR	$\bar{x}$; input, item 33
XBASEI	ξ coordinate of separated store base at t = 0
XBPO	x_B coordinate of leading edge of pylon root chord
XBPOI	x'_B coordinate of leading edge of pylon root chord
XBRO	x_B coordinate of tip of rack nose
XBROI	x'_B coordinate of tip of rack nose
XBSO(I)	x_B coordinate of tip of nose of i^{th} store
XBSOI(I)	x'_B coordinate of tip of nose of i^{th} store
XBWOC	x_B coordinate of wing root-chord leading edge; input, item 9

Table II-1.- Continued.

XBWOI	x'_B coordinate of wing root-chord leading edge
XCGI	ξ coordinate of separated store moment center at $t = 0$
XEND(N)	end points of polynomials specifying separated store shape; input, item 34
XLEL(I)	x' coordinate of local wing-chord leading edge measured relative to root-chord leading edge
XMOM	$x_{s,m}$; input, item 33
XNOSEI	ξ coordinate of tip of separated store nose at $t = 0$
XP	x' coordinate of pylon root-chord leading edge measured relative to wing root-chord leading edge
XPC	x coordinate of pylon root-chord leading edge measured relative to wing root-chord leading edge
XRNC	input, item 22
XRNI	value of XRNC in incompressible space
XSEP	$x_{s,o}$
XTAIL	input, item 38
XWRO	x coordinate of tip of rack nose measured from wing root-chord leading edge
XWROI	value of XWRO in incompressible space
XWSO(I)	x coordinate of tip of nose of i^{th} store measured from wing root-chord leading edge
XWSOI(I)	value of XWSO(I) in incompressible space
YBAR	$\bar{y}$; input, item 33
YBASEI	η coordinate of separated store base at $t = 0$
YBPO	y_B coordinate of pylon
YBRO	y_B coordinate of rack
YBSO(I)	y_B coordinate of i^{th} store
YCGI	η coordinate of separated store moment center at $t = 0$
YNOSEI	η coordinate of tip of separated store nose at $t = 0$
YWRO	y location of rack in wing coordinate system

Table II-1.- Concluded.

Z(I)	input, item 19
ZBAR	$\bar{z}$; input, item 33
ZBASEI	ζ coordinate of separated store base at t = 0
ZBPO	z_B coordinate of pylon root-chord leading edge
ZBRO	z_B coordinate of tip of rack nose
ZBSO(I)	z_B coordinate of tip of nose of i^{th} store
ZBWO	z_B coordinate of wing root-chord leading edge; input, item 9
ZCGI	ζ coordinate of separated store moment center at t = 0
ZLEL(I)	z coordinate of local wing-chord leading edge measured relative to root-chord leading edge
ZNOSEI	ζ coordinate of tip of separated store nose at t = 0
ZP	z coordinate of pylon root-chord leading edge measured relative to wing root-chord leading edge
ZRN	input, item 22
ZWRO	z location of tip of rack nose measured relative to wing root-chord leading edge

TABLE II-2

DICTIONARY OF NOTATION IN SUBROUTINE EMPFOR

The following list presents most of the variable names used in subroutine EMPFOR. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figures 8 and 10 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. The x_B, y_B, z_B coordinate system is shown in figure 13 of this report.

PROGRAM NOTATION	ALGEBRAIC NOTATION
ABU	$\alpha_u + \beta_u$, equations (I-28) and (I-37)
ALFACR	α_f, radians
ANG	ϕ_f, radians (fig. 10)
AS	α_s, equation (I-16)
BETA	β
BS	β_s, equation (I-20)
CCL3(K)	$(cc_\ell)_3$ and $(cc_\ell)_4$, equations (I-14) and (I-19); equal since $s_h = s_v$
CCL5(K)	$(cc_\ell)_5$ if planar empennage, equation (I-29); $(cc_\ell)_6$ if cruciform empennage, equations (I-38) and (I-51)
CCLEM	$(C_\ell)_E$, equations (62) and (I-30) or equations (63) and (I-52)
CLMEM	$(C_m)_E$, equation (60)
CLNEM	$(C_n)_E$, equation (61)
CNEM	$(C_N)_E$, equation (58)
CYEM	$(C_Y)_E$, equation (59)
DTR	degrees to radians conversion factor, 1/57.29578
FCONA	$(dC_L/d\alpha)_H/\pi(s_h - a)^2$
FCONB	FCONA/ℓ_R

Table II-2.- Continued.

FCONC	$\ell_f - x_{s,m}$, figure 8
FROLE(K)	$\phi_f + 90°$ for fin 1, $\phi_f + 270°$ for fin 2, $\phi_f + 180°$ for fin 3, ϕ_f for fin 4; radians; see figure 10
IPLNR	empennage type; input, item 37
IT	body segment number at which the empennage forces act
JMAX	number of tail fins
MSF	input, item 37
NDAMP	input, item 31
NGAM	input, item 31
NHSEG	number of points along store axis where velocity field was calculated
NROLL	input, item 31
PHIROL	ϕ_f; input, item 38
RADAV	average body radius in fin region; input, item 38
RFIN(K)	$a + \left(\frac{K - 1}{MSF - 1}\right)(s_h - a)$ or $a + \left(\frac{K - 1}{MSF - 1}\right)(s_v - a)$; figure 10 with $s_h = s_v$
UTL(K,J)	U_s^* at the k^{th} control point on the j^{th} fin
VAR(N) N = 1,2,...12	$\dot{\xi},\dot{\eta},\dot{\zeta},p,q,r,\xi,\eta,\zeta,\Psi,\Theta,\Phi$, respectively
VINF	V_∞; input, item 3
VN(K,J)	velocity normal to the surface of the j^{th} fin at the k^{th} control point
VO	V_o/V_{∞_s}, see figure 10
VRATIO	V_∞/V_{∞_s}
VSO	V_s^* in the y_s direction of figure 10
VSTORE	V_{∞_s}, equation (41)
VTL(K,J)	V_s^* at the k^{th} control point on the j^{th} fin
WO	W_o/V_{∞_s}, see figure 10

Table II-2.- Concluded.

WSO	W_s^* in the z_s direction of figure 10
WTL(K,J)	W_s^* at the k^{th} control point on the j^{th} fin
XB	$x'_{B_{space}}$ coordinate of a fin control point in incompressible
XMOM	$x_{s,m}$; input, item 33, positive quantity
XTAIL	input, item 38
YB	y_B coordinate of a fin control point
YTAIL(K,J)	$y_{s_{fin}}$ coordinate of the k^{th} control point on the j^{th}
ZB	z_B coordinate of a fin control point
ZTAIL(K,J)	$z_{s_{fin}}$ coordinate of the k^{th} control point on the j^{th}

TABLE II-3

DICTIONARY OF NOTATION IN SUBROUTINE EMPINI

The following list presents most of the variable names used in subroutine EMPINI. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figures 8 and 10 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
AKK1	$K(k_1)$, equation (I-43)
AK1	k_1, equation (I-42)
ARG3	A_1, equation (I-44)
A2	a^2, figure 10
A4	a^4, figure 10
BETA	β
CAPRSQ	R^2, equation (I-39)
CCL3(K)	$(cc_\ell)_3$ and $(cc_\ell)_4$, equations (I-14) and (I-19); equal since $s_h = s_v$
CCL5(K)	$(cc_\ell)_5$ if planar empennage, equation (I-29); $(cc_\ell)_6$ if cruciform empennage, equations (I-38) and (I-51)
CK	$\sqrt{1 - AK1*AK1} = \sqrt{1 - k_1^2}$
CKCK	$1 - k_1^2$
CTWGAM	$\cos 2\gamma$, equation (I-41)
CTWTHE	$\cos 2\theta$, equation (I-40)
DTR	degrees to radians conversion factor, 1/57.29578
EAK	$E(A_1,k_1)$, equation (I-49)
EPIO2K	$E(\pi/2,k_1)$, equation (I-48)
FAK	$F(A_1,k_1)$, equation (I-47)

Table II-3.- Concluded.

FCONA	$(dC_L/d\alpha)_H/\pi(s_h - a)^2$
FCONB	FCONA/ℓ_R
FCONC	$\ell_f - x_{s,m}$, figure 8
FINSS	tail fin semispan; input, item 38
FROLE(K)	$\phi_f + 90°$ for fin 1, $\phi_f + 270°$ for fin 2, $\phi_f + 180°$ for fin 3, ϕ_f for fin 4; radians; see figure 10
IPLNR	empennage type; input, item 37
JMAX	number of tail fins
MSF	input, item 37
NROLL	input, item 31
PHIROL	ϕ_f; input, item 38
RADAV	average body radius in fin region; input, item 38
RFIN(K)	$a + \left(\frac{K - 1}{MSF - 1}\right)(s_h - a)$ or $a + \left(\frac{K - 1}{MSF - 1}\right)(s_v - a)$; figure 10 with $s_h = s_v$
SHS	s_h^2
STWGAM	sin 2γ, equations (I-41) and (I-42)
TOVPI	$2/\pi$
TTWGAM	tan 2γ, equations (I-41) and (I-42)
TWOTHE	2θ, equation (I-40)
XTAIL	input, item 38
XTAILI	XTAIL in incompressible space
YTAIL(K,J)	y_s coordinate of the k^{th} control point on the j^{th} fin
ZTAIL(K,J)	z_s coordinate of the k^{th} control point on the j^{th} fin

TABLE II-4

DICTIONARY OF NOTATION IN SUBROUTINE FORCE

The following list presents most of the variable names used in subroutine FORCE. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Primes associated with the algebraic notation indicate incompressible space (see section 3 of ref. 1). The x_B, y_B, z_B coordinate system is shown in figure 13 of this report.

PROGRAM NOTATION	ALGEBRAIC NOTATION
ALFACR	α_f, radians
BETA	β
CDC	c_{d_c} ; input, item 36
CLMBY	$(C_m)_{BY}$, equation (44)
CLMCF	$(C_m)_{CF}$, equation (53)
CLMSB	$(C_m)_{SB}$, equation (48)
CLNBY	$(C_n)_{BY}$, equation (45)
CLNCF	$(C_n)_{CF}$, equation (54)
CLNSB	$(C_n)_{SB}$, equation (49)
CNBY	$(C_N)_{BY}$, equation (42)
CNCF	$(C_N)_{CF}$, equation (51)
CNSB	$(C_N)_{SB}$, equation (46)
CNX(NN)	total dC_N/dx_s at the midpoint of the NN^{th} body segment
CONA	$2/a^2_{max}$
CONB	$2c_{d_c}/\pi a^2_{max}$

Table II-4.- Continued.

CRIFI	cosine of the angle between the rack longitudinal axis and the fuselage longitudinal axis in incompressible space; measured in x'_B, z_B plane
CYBY	$(C_Y)_{BY}$, equation (43)
CYCF	$(C_Y)_{CF}$, equation (52)
CYSB	$(C_Y)_{SB}$, equation (47)
CYX(NN)	total dC_Y/dx_s at the midpoint of the NN^{th} body segment
DC(I,J)	[A], equation (28)
DCN	dC_N/dx_s
DCY	dC_Y/dx_s
DELX	length of a body segment; store length divided by NSEG which was input in item 31
DX	DELX/2
EDRDX(I)	da/dx_s at the midpoint of the i^{th} segment of the separated store
ERAD(I)	a at the midpoint of the i^{th} segment of the separated store
ESTRMX	a_{max} of separated store
ETA	η coordinate of point on store axis measured relative to store moment center
NDAMP	input, item 31
NGAM	input, item 31
NHSEG	number of points along store axis where velocity field is to be calculated; NHSEG = 2*NSEG + 1
NHSEGO	number of points along store axis ahead of separation point where velocity field is to be calculated; NHSEGO = 2*NSEGXO + 1
NRACK	input, item 4
NSEG	input, item 31
NSEGXO	input, item 31
RIIR	rack incidence angle in incompressible space, radians

Table II-4.- Concluded.

SRIFI	sine of the angle between the rack longitudinal axis and the fuselage longitudinal axis in incompressible space; measured in x'_B, z_B plane
UT(N)	U_s^* at the N^{th} point along body, equation (40)
VAR(N), N = 1,2,...12	$\dot{\xi}, \dot{\eta}, \dot{\zeta}, p, q, r, \xi, \eta, \zeta, \Psi, \Theta, \Phi$ respectively
VC	V_C^*, equation (55)
VETA	η component of the store free-stream velocity vector, equation (32)
VINF	V_∞; input, item 3
VRATIO	V_∞ / V_{∞_s}
VSTORE	V_{∞_s}, equation (41)
VT(N)	V_s^* at the N^{th} point along body, equation (40)
VX	U_{∞_s, x_s} equation (35)
VXI	ξ component of the store free-stream velocity vector, equation (32)
VY	$-V_{\infty_s, y_s}$ equation (35)
VZ	W_{∞_s, z_s} equation (35)
VZETA	ζ component of the store free-stream velocity vector, equation (32)
WIIR	wing incidence angle in incompressible space, radians
WT(N)	W_s^* at the N^{th} point along body, equation (40)
XB	x'_B coordinate of a point along store body axis
XI	ξ coordinate of a point on store axis measured relative to store moment center
XMOM	$x_{s,m}$; input, item 33
XSTOR	x_s coordinate of point on store axis
XXX	x coordinate of point on store axis
YB	y_B coordinate of a point along store body axis
ZB	z_B coordinate of a point along store body axis
ZETA	ζ coordinate of a point on store axis measured relative to store moment center

TABLE II-5

DICTIONARY OF NOTATION IN SUBROUTINE OUTPUT

The following list presents most of the variable names used in subroutine OUTPUT. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. The x_B, y_B, z_B coordinate system is shown in figure 13 of this report.

PROGRAM NOTATION	ALGEBRAIC NOTATION
CLLEM	$(C_\ell)_E$, equations (62) and (I-30) or equations (63) and (I-52)
CLLT	total C_ℓ
CLMBY	$(C_m)_{BY}$, equation (44)
CLMCF	$(C_m)_{CF}$, equation (53)
CLMEM	$(C_m)_E$, equation (60)
CLMSB	$(C_m)_{SB}$, equation (48)
CLMT	total C_m
CLNBY	$(C_n)_{BY}$, equation (45)
CLNCF	$(C_n)_{CF}$, equation (54)
CLNEM	$(C_n)_E$, equation (61)
CLNSB	$(C_n)_{SB}$, equation (49)
CLNT	total C_n
CNBY	$(C_N)_{BY}$, equation (42)
CNCF	$(C_N)_{CF}$, equation (51)
CNEM	$(C_N)_E$, equation (58)
CNSB	$(C_N)_{SB}$, equation (46)
CNT	total C_N
CNX(K)	total dC_N/dx_s at the midpoint of the K^{th} body segment
CYBY	$(C_Y)_{BY}$, equation (43)

Table II-5.- Continued.

CYCF	$(C_Y)_{CF}$, equation (52)
CYEM	$(C_Y)_E$, equation (59)
CYSB	$(C_Y)_{SB}$, equation (47)
CYT	total C_Y
CYX(K)	total dC_Y/dx_s at the midpoint of the K^{th} body segment
DC(I,J)	[A], equation (28)
DVAR(N), N = 1,2,...12	$\ddot{\xi},\ddot{\eta},\ddot{\zeta},\dot{p},\dot{q},\dot{r},\dot{\xi},\dot{\eta},\dot{\zeta},\dot{\Psi},\dot{\theta},\dot{\Phi}$ respectively
DXB	ξ coordinate of the store base at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DXCG	ξ coordinate of the store moment center at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DXN	ξ coordinate of the store nose at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DYB	η coordinate of the store base at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DYCG	η coordinate of the store moment center at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DYN	η coordinate of the store nose at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DZB	ζ coordinate of the store base at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DZCG	ζ coordinate of the store moment center at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
DZN	ζ coordinate of the store nose at time t relative to where it would have been had it remained in the t = 0 position on the aircraft
ESTLGC	ℓ_s of separated store

Table II-5.- Continued.

ETA	η coordinate of point on store axis measured relative to store moment center
EXST(J)	x_s at the J^{th} point along store axis
PHI	Φ, degrees
PSI	Ψ, degrees
SLTHC(NEJSTR)	ℓ_s of separated store
THA	Θ, degrees
TIME	t
UT(J)	U_s^* at J^{th} point along store axis
VAR(N), N = 1,2,...12	$\dot{\xi},\dot{\eta},\dot{\zeta},p,q,r,\xi,\eta,\zeta,\Psi,\Theta,\Phi$ respectively
VT(J)	V_s^* at J^{th} point along store axis
WT(J)	W_s^* at J^{th} point along store axis
XBASE	ξ coordinate of separated store base at time t
XBASEI	ξ coordinate of separated store base at t = 0
XCGI	ξ coordinate of separated store moment center at t = 0
XI	ξ coordinate of point on store axis measured relative to store moment center
XL	x_s/ℓ_s
XMOM	$x_{s,m}$
XNOSE	ξ coordinate of separated store nose at time t
XNOSEI	ξ coordinate of separated store nose at t = 0
XXX	x coordinate of point on store axis
YBASE	η coordinate of separated store base at time t
YBASEI	η coordinate of separated store base at t = 0
YCGI	η coordinate of separated store moment center at t = 0
YNOSE	η coordinate of separated store nose at time t
YNOSEI	η coordinate of separated store nose at t = 0

Table II-5.- Concluded.

ZBASE	ζ coordinate of separated store base at time t
ZBASEI	ζ coordinate of separated store base at t = 0
ZCGI	ζ coordinate of separated store moment center at t = 0
ZETA	ζ coordinate of point on store axis measured relative to store moment center
ZNOSE	ζ coordinate of separated store nose at time t
ZNOSEI	ζ coordinate of separated store nose at t = 0

TABLE II-6

DICTIONARY OF NOTATION IN SUBROUTINE PTHIN

The following list presents most of the variable names used in subroutine PTHIN. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 6 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
BETA	β
CRP	length of pylon root chord; input, item 17
CRPI	length of pylon root chord in incompressible space; CRP/BETA
DELTPX(I)	ΔX_i; equals $X_a - X_b$ of figure 6 of reference 1
FACTOP(I)	$\theta_p \Delta X_i \cos \psi_i / 2\pi$ of i^{th} pylon thickness source strip
KMAX	MSP + 1
MPS	number of pylon thickness source strips; MPS = NCPS*MSP
MSP	input, item 18
NCPS	input, item 20
NUNIP	input, item 20
SWPPCS(I)	$\tan \psi_i$
SWPPLI	tangent of pylon leading-edge sweep angle in incompressible space
SWPPTI	tangent of pylon trailing-edge sweep angle in incompressible space
THETPL(I)	θ_p of the i^{th} pylon thickness source strip
TWOPI	2π
XP	x' coordinate of pylon root-chord leading edge measured relative to wing root-chord leading edge

Table II-6.- Concluded.

XPRC(I)	X_{p_c} of i^{th} pylon thickness source strip; see figure 6 of reference 1
Z(K)	input, item 19

TABLE II-7

DICTIONARY OF NOTATION IN SUBROUTINE PVLIN

The following list presents most of the variable names used in subroutine PVLIN. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 2 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
BETA	β
CRP	length of pylon root chord; input, item 17
CRPI	length of pylon root chord in incompressible space
DTR	degrees to radians conversion factor, 1/57.29578
H	pylon height; input, item 17
IP	input, item 17
KMAX	MSP + 1
M	number of vortices on wing
MMP	M + MP
MP	number of vortices on pylon
MP1	M + 1
MSP	input, item 18
NCP	input, item 18
PCPX(I)	X coordinate of the control point associated with the i^{th} vortex on the pylon
PHIP	angle between the pylon and wing planform planes, $-\pi/2$
PSIPLE	sweep angle of pylon leading edge; input, item 17
PSIPTE	sweep angle of pylon trailing edge; input, item 17

Table II-7.- Concluded.

PVPX(I)	X coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPY(I)	Y coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} pylon vortex
SP(I)	semispan, s, of the i^{th} pylon vortex
SWPCR(I)	tangent of the sweep angle of the 3/4-chord line of the area element associated with the i^{th} pylon vortex
SWPPLE	tan(PSIPLE)
SWPPLI	tan(PSIPLE) in incompressible space
SWPPTE	tan(PSIPTE)
SWPPTI	tan(PSIPTE) in incompressible space
SWPVP(I)	tan ψ of the i^{th} pylon vortex
XLEL(IP)	X coordinate of the wing leading edge at the pylon location
XP	X coordinate of the pylon root-chord leading edge
XPLE	location of pylon root-chord leading edge relative to local wing-chord leading edge; input, item 17
XPLEI	location of pylon root-chord leading edge relative to local wing-chord leading edge in incompressible space
Y(IP)	Y location of pylon
YP	Y(IP)
Z(K)	input, item 19
ZLEL(IP)	Z coordinate of wing leading edge at pylon location
ZP	ZLEL(IP)

TABLE II-8

DICTIONARY OF NOTATION IN SUBROUTINE STRIO

The following list presents most of the variable names used in subroutine STRIO. Where possible a variable name is identified by a symbol in the list of symbols in reference 1. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
BETA	β
DUMQ(J)	input, item 30
DUMX(J)	input, item 29
MSHAPE	input, item 28
MSOR	input, item 28
NSHAPE(J)	input, item 26
NSHPT	input, item 27
NSSOR(K)	number of sources in the source distribution representing the volume of the K^{th} store
NSTRS	input, item 4
NUMSTR(J)	input, item 26
RAD	radians to degrees conversion factor, 57.29578
SIC(J)	input, item 26
SII(J)	value of SIC(J) in incompressible space
SLTHC(J)	input, item 26
SLTHI(J)	value of SLTHC(J) in incompressible space
SRMAX(J)	input, item 26
SSOR(K,J)	array containing the k values of $Q_k/4\pi V_\infty$ for the j^{th} store

Table II-8.- Concluded.

SXL(K,J)	array containing the k values of x' at which the sources are located for the j^{th} store; negative and measured from the tip of the nose
XLEL(I)	X coordinate of wing leading edge at Y = Y(I)
XSNC(J)	input, item 26
XSNI(J)	value of XSNC(J) in incompressible space
XWSOI(J)	X coordinate of tip of nose of j^{th} store
Y(I)	input, item 12
YWSO(J)	Y coordinate of tip of nose of j^{th} store, input
YSN(J)	input, item 26
ZLEL(I)	Z coordinate of wing leading edge at Y = Y(I)
ZSN(J)	input, item 26
ZWSO(J)	Z coordinate of tip of nose of j^{th} store

TABLE II-9

DICTIONARY OF NOTATION IN SUBROUTINE THPVEL

The following list presents most of the variable names used in subroutine THPVEL. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 6 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALBEGRAIC NOTATION
COSSPS(I)	$\cos \psi_i$
COSSWP	$\cos \psi_i$
DZ	$Z - Z_a$
DZB	$Z - Z_b$
E	E, equation (26)
F	F, equation (26)
FACTOP(I)	$\theta_p \Delta X_i \cos \psi_i / 2\pi$
G	G, equation (26)
GD	FACTOP(I)
H	H, equation (26)
JPS	i
KMAX	MSP + 1
MSP	input, item 18
NCPS	input, item 20
SINSPS(I)	$\sin \psi_i$
SINSWP	$\sin \psi_i$
SWPPCS(I)	$\tan \psi_i$

Table II-9.- Concluded.

U	$\sum_i \left(\frac{\Delta u}{V_\infty}\right)_i$, equation (25)
UP	total wing-pylon u/V_∞ perturbation velocity at point X,Y,Z
V	$\sum_i \left(\frac{\Delta v}{V_\infty}\right)_i$, equation (25)
VP	total wing-pylon v/V_∞ perturbation velocity at point X,Y,Z
W	$\sum_i \left(\frac{\Delta w}{V_\infty}\right)_i$, equation (25)
WP	total wing-pylon w/V_∞ perturbation velocity at point X,Y,Z
XC	X coordinate of field point
XPRC(I)	X_{p_c} of i^{th} pylon thickness source strip
Y(IP)	Y_p location of pylon
YC	Y coordinate of field point
Z(K)	input, item 19
ZC	Z coordinate of field point
ZLEL(IP)	Z coordinate of wing leading edge at pylon location

TABLE II-10

DICTIONARY OF NOTATION IN SUBROUTINE THWVEL

The following list presents most of the variable names used in subroutine THWVEL. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 5 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
A	A, equation (20)
B	B, equation (20)
C	C, equation (20)
COSSWP	$\cos \psi_i$
COSSWS(I)	$\cos \psi_i$
D	D, equation (20)
F	± 1
FACTOR(I)	$\theta \Delta X_i \cos \psi_i / 2\pi$
IMAX	MSW + 1
MSW	input, item 11
NCWS	input, item 15
SINSWP	$\sin \psi_i$
SINSWS(I)	$\sin \psi_i$
SWPCS(I)	$\tan \psi_i$
U	$\sum_i \left(\frac{\Delta u}{V_\infty}\right)_i$, equation (19)
UW	u/V_∞ perturbation velocity due to wing-pylon vortex lattice and wing thickness

Table II-10.- Concluded.

V	$\sum_i \left(\frac{\Delta v}{V_\infty}\right)_i$, equation (19)
VW	v/V_∞ perturbation velocity due to wing-pylon vortex lattice and wing thickness
W	$\sum_i \left(\frac{\Delta w}{V_\infty}\right)_i$, equation (19)
WW	w/V_∞ perturbation velocity due to wing-pylon vortex lattice and wing thickness
XC	X coordinate of field point
XRC(I)	X_c of i^{th} wing thickness source strip
Y(I)	input, item 12
YC	Y coordinate of field point
ZC	Z coordinate of field point
Z1(I)	Z coordinate of i^{th} wing thickness source strip

TABLE II-11

DICTIONARY OF NOTATION IN SUBROUTINE VELFLD

The following list presents most of the variable names used in subroutine VELFLD. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Primes associated with the algebraic notation indicate incompressible space (see section 3 of ref. 1). The x_B, y_B, z_B coordinate system is shown in figure 13 of this report.

PROGRAM NOTATION	ALGEBRAIC NOTATION
ALFACR	α_f, radians
BETA	β
BETASQ	β^2
CRIFI	cosine of the angle between the rack longitudinal axis and the fuselage longitudinal axis in incompressible space, measured in x'_B, z_B plane
CSIBIR(J)	cosine of the angle between the longitudinal axis of the J^{th} store and the fuselage longitudinal axis in incompressible space, measured in x'_B, z_B plane
CWIIR	cosine of the angle between the wing root chord and the fuselage longitudinal axis in incompressible space, measured in x'_B, z_B plane
DC(I,J)	[A], equation (28)
FRMAX	fuselage maximum radius; input, item 5
FSOR(N)	array containing the strengths of the fuselage source distribution
FXL(N)	array containing the x'_B positions of the fuselage sources
IP	pylon location specification; input, item 17
NCON	control index used in subroutine VLIVEL
NEJSTR	subscript associated with separated store, $1 \leq$ NEJSTR $\leq$ NSTRS

Table II-11.- Continued.

NFSOR	number of fuselage sources; input, item 6
NFU	input, item 4
NPY	input, item 4
NRACK	input, item 4
NRSOR	number of rack sources; input, item 23
NSSOR(J)	number of sources in the source distribution representing the volume of the J^{th} store
NSTRS	input, item 4
RRMAX	rack maximum radius; input, item 22
RSOR(N)	array containing the strengths of the rack source distribution
RXL(N)	array containing the axial locations of the rack sources
SALF	$\sin \alpha_f'$
SRIFI	sine of the angle between the rack longitudinal axis and the fuselage longitudinal axis in incompressible space, measured in x_B', z_B plane
SRMAX(J)	maximum radius of J^{th} store
SSIBIR(J)	sine of the angle between the longitudinal axis of the J^{th} store and the fuselage longitudinal axis in incompressible space, measured in x_B', z_B plane
SSOR(K,J)	array containing the K values of the source strengths of the source distribution for the J^{th} store
SWIIR	sine of the angle between the wing root chord and the fuselage longitudinal axis in incompressible space, measured in x_B', z_B plane
SXL(K,J)	array containing the K axial locations of the sources for the J^{th} store
UF	u/V_∞ perturbation velocity due to a component of the parent aircraft
UTU	during calculation, sum of u/V_∞ perturbation velocities due to parent aircraft in incompressible fuselage coordinate system; upon return to calling program, sum of u/V_∞ perturbation velocities in compressible space in separated store x,y,z coordinate system

Table II-11.- Continued.

VF	v/V_∞ perturbation velocity due to a component of the parent aircraft
VTV	during calculation, sum of v/V_∞ perturbation velocities due to parent aircraft in incompressible fuselage coordinate system; upon return to calling program, sum of v/V_∞ perturbation velocities in compressible space in separated store, x,y,z coordinate system
WF	w/V_∞ perturbation velocity due to a component of the parent aircraft
WTW	during calculation, sum of w/V_∞ perturbation velocities due to parent aircraft in incompressible fuselage coordinate system; upon return to calling program, sum of w/V_∞ perturbation velocities in compressible space in separated store, x,y,z coordinate system
XB	x'_B coordinate of point where velocity field is to be calculated
XBROI	x'_B coordinate of tip of rack nose
XBSOI(J)	x'_B coordinate of tip of nose of J^{th} store
XBWOI	x'_B coordinate of wing root-chord leading edge
XR	x' coordinate of point where velocity field is to be calculated measured in rack coordinate system
XS	x' coordinate of point where velocity field is to be calculated measured in J^{th} store coordinate system
XW	x' coordinate of point where velocity field is to be calculated measured in wing coordinate system
YB	y_B coordinate of point where velocity field is to be calculated
YBRO	y_B coordinate of rack
YBSO(J)	y_B coordinate of J^{th} store
YR	y coordinate of point where velocity field is to be calculated measured in rack coordinate system
YS	y coordinate of point where velocity field is to be calculated measured in J^{th} store coordinate system
YW	y coordinate of point where velocity field is to be calculated measured in wing coordinate system

Table II-11.- Concluded.

ZB	z_B coordinate of point where velocity field is to be calculated
ZBRO	z_B coordinate of tip of rack nose
ZBSO(J)	z_B coordinate of tip of nose of J^{th} store
ZBWO	z_B coordinate of wing root-chord leading edge
ZR	z coordinate of point where velocity field is to be calculated measured in rack coordinate system
ZS	z coordinate of point where velocity field is to be calculated measured in J^{th} store coordinate system
ZW	z coordinate of point where velocity field is to be calculated measured in wing coordinate system

TABLE II-12

DICTIONARY OF NOTATION IN SUBROUTINE VLCOEF

The following list presents most of the variable names used in subroutine VLCOEF. Where possible a variable name is identified by a symbol in the list of symbols or in section 4.2.2 of reference 1. Symbols in figure 2 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Certain of the variable names appearing in the following list are marked with an asterisk, *. These variables are dimensioned for two (2) in the subroutine. The subscript one (1) pertains to the left wing panel or pylon while the subscript two (2) pertains to the image vortex on the right wing panel or pylon.

PROGRAM NOTATION	ALGEBRAIC NOTATION
COSPHI(JC)	$\cos \phi_\nu$, equation (6)
FUP*	$F_{u_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the pylon vortex
FUW*	$F_{u_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the wing vortex
FVN(JC,JV)	coefficient in equation (6) or (7) of $\Gamma_n/4\pi V_\infty$ in the ν^{th} equation; JC = ν, JV = n
FVP*	$F_{v_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the pylon vortex
FVW*	$F_{v_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the wing vortex
FWP*	$F_{w_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the pylon vortex
FWW*	$F_{w_{n^{th}}}$ at the ν^{th} wing or pylon control point due to the wing vortex
IP	pylon location specification; input, item 17 (IP = 1 under fuselage centerline)
JC	control point index ν in equation (6) or (7)
JCP	index of the i^{th} pylon control point, JCP = 1,2,... MP

Table II-12.- Continued.

JV	vortex index n in equation (6) or (7)
JVP	index of the i^{th} pylon vortex, JVP = 1,2,...MP
M	number of vortices on wing
MMP	M + MP
MP	number of vortices on pylon
MP1	M + 1
NPY	input, item 4; NPY = 0, no pylon
PCPX(I)	X coordinate of the control point associated with the i^{th} vortex on the pylon
PCX(I)	X coordinate of the control point associated with the i^{th} vortex on the wing
PHI(I)	dihedral angle, ϕ_i, associated with the i^{th} vortex on the wing
PHIP	angle between the pylon and wing planform planes, $-\pi/2$
PVPX(I)	X coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPY(I)	Y coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVX(I)	X coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVY(I)	Y coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} wing vortex
SINPHI(JC)	sin ϕ_ν, equation (6)
SP(I)	semispan, s, of the i^{th} pylon vortex
SW(I)	semispan, s, of the i^{th} wing vortex
SWPVP(I)	tan ψ of the i^{th} pylon vortex
SWPVV(I)	tan ψ of the i^{th} wing vortex

Table II-12.- Concluded.

XPP	x location of the ν^{th} pylon control point relative to the n^{th} pylon vortex
XPW	x location of the ν^{th} pylon control point relative to the n^{th} wing vortex
XWP	x location of the ν^{th} wing control point relative to the n^{th} pylon vortex
XWW	x location of the ν^{th} wing control point relative to the n^{th} wing vortex
YPP*	y location of the ν^{th} pylon control point relative to the n^{th} pylon vortex
YPW*	y location of the ν^{th} pylon control point relative to the n^{th} wing vortex
YWP*	y location of the ν^{th} wing control point relative to the n^{th} pylon vortex
YWW*	y location of the ν^{th} wing control point relative to the n^{th} wing vortex
ZPP	z location of the ν^{th} pylon control point relative to the n^{th} pylon vortex
ZPW	z location of the ν^{th} pylon control point relative to the n^{th} wing vortex
ZWP	z location of the ν^{th} wing control point relative to the n^{th} pylon vortex
ZWW	z location of the ν^{th} wing control point relative to the n^{th} wing vortex

TABLE II-13

DICTIONARY OF NOTATION IN SUBROUTINE VLIVEL

The following list presents most of the variable names used in subroutine VLIVEL. Where possible a variable name is identified by a symbol in the list of symbols or in section 4.2.2 of reference 1. Symbols in figure 2 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Certain of the variable names appearing in the following list are marked with an asterisk, *. These variables are dimensioned for two (2) in the subroutine. The subscript one (1) pertains to the left wing panel or pylon while the subscript two (2) pertains to the image vortex on the right wing panel or pylon.

PROGRAM NOTATION	ALGEBRAIC NOTATION
CIR(JV)	Γ_n/V_∞ of the n^{th} wing or pylon vortex; JV = n
FUP*	F_u at the field point due to the n^{th} pylon vortex
FUW*	F_u at the field point due to the n^{th} wing vortex
FVP*	F_v at the field point due to the n^{th} pylon vortex
FVW*	F_v at the field point due to the n^{th} wing vortex
FWP*	F_w at the field point due to the n^{th} pylon vortex
FWW*	F_w at the field point due to the n^{th} wing vortex
JV	vortex index n in equation (6) or (7)
JVP	index of the i^{th} pylon vortex, JVP = 1,2,...MP
M	number of vortices on wing
MMP	M + MP
MP	number of vortices on pylon
MP1	M + 1
NCON	control index set in subroutine VELFLD; if NCON = 2 only pylon thickness velocities are to be calculated
NCP	input, item 18

Table II-13.- Continued.

PHI(I)	dihedral angle, ϕ_i, associated with the i^{th} vortex on the wing
PHIP	angle between the pylon and wing planform planes, $-\pi/2$
PMX	X coordinate of field point
PMY	Y coordinate of field point
PMZ	Z coordinate of field point
PVPX(I)	X coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPY(I)	Y coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVPZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} pylon vortex
PVX(I)	X coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVY(I)	Y coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} wing vortex
SP(I)	semispan, s, of the i^{th} pylon vortex
SW(I)	semispan, s, of the i^{th} wing vortex
SWPVP(I)	tan ψ of the i^{th} pylon vortex
SWPVV(I)	tan ψ of the i^{th} wing vortex
UI	u/V_∞ perturbation velocity at field point in incompressible space
VI	v/V_∞ perturbation velocity at field point in incompressible space
WI	w/V_∞ perturbation velocity at field point in incompressible space
XPM	x location of field point relative to the i^{th} pylon vortex
XWM	x location of field point relative to the i^{th} wing vortex

Table II-13.- Concluded.

YPM*	y location of field point relative to the i^{th} pylon vortex
YWM*	y location of field point relative to the i^{th} wing vortex
ZPM	z location of field point relative to the i^{th} pylon vortex
ZWM	z location of field point relative to the i^{th} wing vortex

TABLE II-14

DICTIONARY OF NOTATION IN SUBROUTINE VLRHS

The following list presents most of the variable names used in subroutine VLRHS. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition. Primes associated with the algebraic notation indicate incompressible space (see section 3 of ref. 1). The x_B, y_B, z_B fuselage coordinate system is shown in figure 13 of this report. Each of the other axisymmetric bodies has a coordinate system associated with it as is shown in figure 1 of reference 1. The X,Y,Z wing-pylon coordinate system is shown in figure 2 of that reference.

PROGRAM NOTATION	ALGEBRAIC NOTATION
ALFAIR	α_f', radians
ALPHLI(N)	α_ℓ in incompressible space; tan α_ℓ in compressible space was input as item 14
CIR(N)	array containing the right-hand sides of equations (6) and (7) of reference 1
COSPHI(I)	cos ϕ_i of the i^{th} wing vortex
CRIIR	cosine of the rack incidence angle in incompressible space; compressible incidence angle was input in item 22
CSIIR(N)	cosine of the N^{th} store incidence angle in incompressible space; compressible incidence angle was input in item 26
CWIIR	cosine of the wing incidence angle in incompressible space; compressible incidence angle was input in item 9
IP	pylon location specification; input, item 17
M	number of vortices on wing
MMP	M + MP
MP	number of vortices on pylon

Table II-14.- Continued.

MP1	M + 1
NFU	input, item 4
NPY	input, item 4
NRACK	input, item 4
NSTRS	input, item 4
PCPX(J)	X coordinate of the control point associated with the j^{th} pylon vortex
PCX(J)	X coordinate of the control point associated with the j^{th} wing vortex
PVPY(J)	Y coordinate of the bound-leg midpoint and control point of the j^{th} pylon vortex
PVPZ(J)	Z coordinate of the bound-leg midpoint and control point of the j^{th} pylon vortex
PVY(J)	Y coordinate of the bound-leg midpoint and control point of the j^{th} wing vortex
PVZ(J)	Z coordinate of the bound-leg midpoint and control point of the j^{th} wing vortex
SINPHI(I)	$\sin \phi_i$ of the i^{th} wing vortex
SRIIR	sine of the rack incidence angle in incompressible space; compressible incidence angle was input in item 22
SSIIR(N)	sine of the N^{th} store incidence angle in incompressible space; compressible incidence angle was input in item 26
SWIIR	sine of the wing incidence angle in incompressible space; compressible incidence angle was input in item 9
UEI(NV)	u_i/V_∞ at the control point of the ν^{th} vortex
UI	u'/V_∞ perturbation velocity at a vortex control point due to an aircraft component
VEI(NV)	v_i/V_∞ at the control point of the ν^{th} vortex
VI	v'/V_∞ perturbation velocity at a vortex control point due to an aircraft component

Table II-14.- Continued.

WEI(NV)	w_i/V_∞ at the control point of the ν^{th} vortex
WI	w'/V_∞ perturbation velocity at a vortex control point due to an aircraft component
WIIR	wing incidence angle in incompressible space; compressible value was input in item 9
XBP	x'_B coordinate of a pylon control point
XBW	x'_B coordinate of a wing control point
XBWOI	x'_B coordinate of wing root-chord leading edge
XRW	x' coordinate of a wing control point in the rack coordinate system
XSP	x' coordinate of a pylon control point in the N^{th} store coordinate system
XSW	x' coordinate of a wing control point in the N^{th} store coordinate system
XWROI	X coordinate of tip of rack nose
XWSOI(N)	X coordinate of tip of nose of N^{th} store
YBP	y_B coordinate of a pylon control point
YBW	y_B coordinate of a wing control point
YRW	y coordinate of a wing control point in the rack coordinate system
YSP	y coordinate of a pylon control point in the N^{th} store coordinate system
YSW	y coordinate of a wing control point in the N^{th} store coordinate system
YWRO	Y coordinate of tip of rack nose
YWSO(N)	Y coordinate of tip of nose of N^{th} store
ZBP	z_B coordinate of a pylon control point
ZBW	z_B coordinate of a wing control point
ZBWO	z_B coordinate of wing root-chord leading edge
ZRW	z coordinate of a wing control point in the rack coordinate system

Table II-14.- Concluded.

ZSP	z coordinate of a pylon control point in the N^{th} store coordinate system
ZSW	z coordinate of a wing control point in the N^{th} store coordinate system
ZWRO	Z coordinate of tip of rack nose
ZWSO(N)	Z coordinate of tip of nose of N^{th} store

TABLE II-15

DICTIONARY OF NOTATION IN SUBROUTINE WTHIN

The following list presents most of the variable names used in subroutine WTHIN. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 5 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

PROGRAM NOTATION	ALGEBRAIC NOTATION
BETA	β
CHLOCB(I)	local incompressible wing chord at the midspan of the $(I - 1)^{th}$ wing segment
CHLOCL(I)	local incompressible wing chord at the left or outboard side of the $(I - 1)^{th}$ wing segment
DELTX(I)	ΔX_i; equals $X_a - X_b$ of figure 5 of reference 1
FACTOR(I)	$\theta \Delta X_i \cos \psi_i / 2\pi$ of the i^{th} wing thickness source strip
IMAX	MSW + 1
MS	number of wing thickness source strips; MS = NCWS*MSW
MSW	input, item 11
NCWS	input, item 15
NUNIS	input, item 15
SWPCS(I)	$\tan \psi_i$ of the i^{th} thickness source strip
SWPWLI(I)	tangent of the leading-edge sweep angle in incompressible space of the $(I - 1)^{th}$ wing segment
SWPWTI(I)	tangent of the trailing-edge sweep angle in incompressible space of the $(I - 1)^{th}$ wing segment
TANPHI(I)	$\tan \phi_i$ of the $(I - 1)^{th}$ wing segment
THETAL(I)	θ of the i^{th} thickness source strip; input in item 16 and then transformed to incompressible space
TWOPI	2π

Table II-15.- Concluded.

XRC(I)	X_{ℓ} of the i^{th} thickness source strip; see figure 5 of reference 1
XLEL(I)	X coordinate of wing leading edge at Y = Y(I)
Y(I)	input, item 12
ZLEL(I)	Z coordinate of wing leading edge at Y = Y(I)
Z1(I)	Z coordinate of i^{th} wing thickness source strip

TABLE II-16

DICTIONARY OF NOTATION IN SUBROUTINE WVLIN

The following list presents most of the variable names used in subroutine WVLIN. Where possible a variable name is identified by a symbol in the list of symbols or an equation number in reference 1. Symbols in figure 2 of that reference are also used. Where a variable is an input quantity, it is so identified and section 4.2.1 of this report should be referred to for the definition.

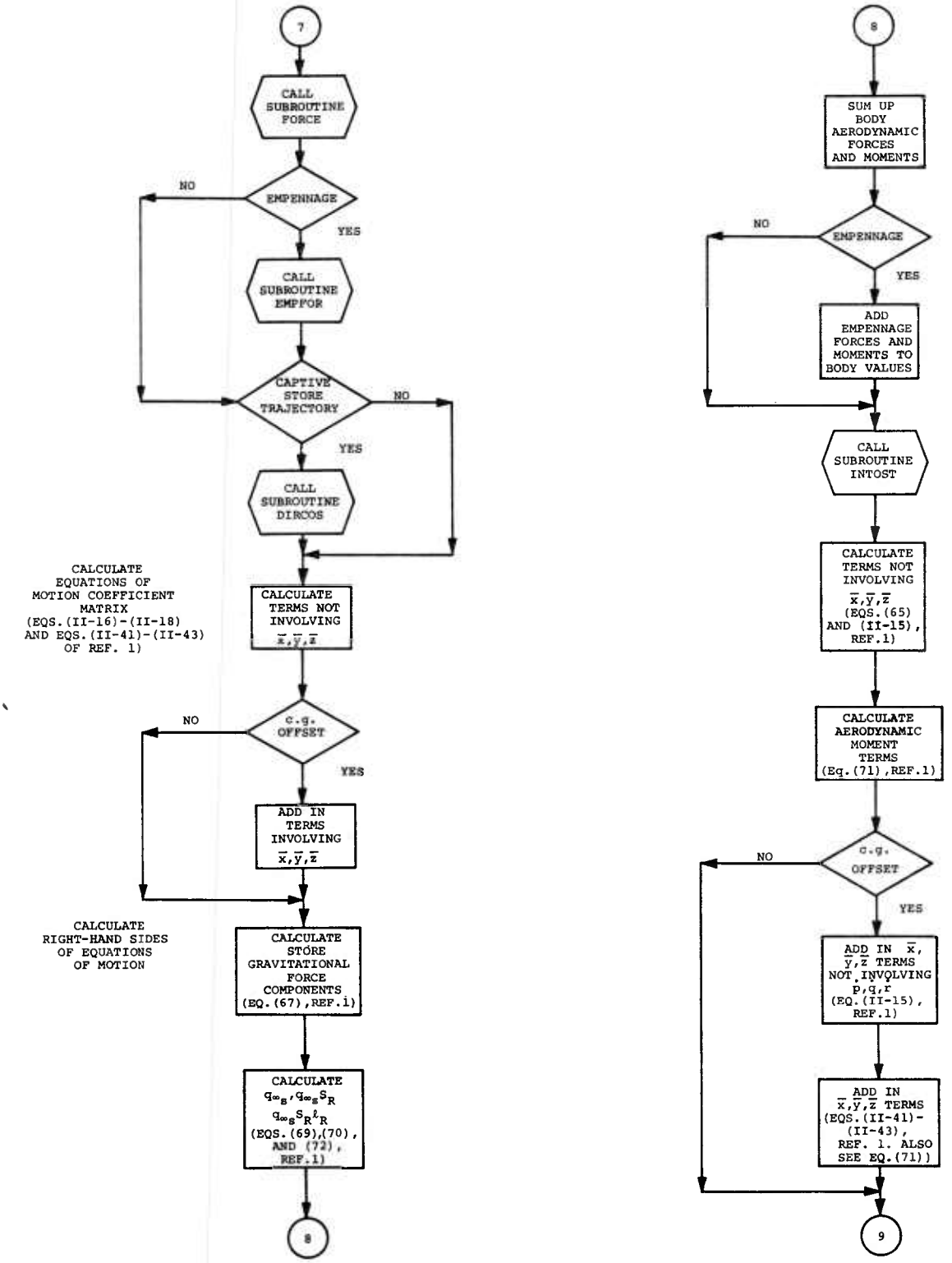
PROGRAM NOTATION	ALGEBRAIC NOTATION
ALPHAL(I)	tan α_ℓ; input, item 14
ALPHLI(I)	tan α_ℓ in incompressible space
BETA	β
CAVE	average wing chord in incompressible space
CHLOCB(I)	local incompressible wing chord at the midspan of the $(I - 1)^{th}$ wing segment
CHLOCL(I)	local incompressible wing chord at the left or outboard side of the $(I - 1)^{th}$ wing segment
COSPHI(I)	cos ϕ_i of the i^{th} wing vortex
CRW	length of wing root chord; input, item 10
CRWI	length of wing root chord in incompressible space
DTR	degrees to radians conversion factor, 1/57.29578
IMAX	MSW + 1
M	number of vortices on wing; M = NCW*MSW
MSW	input, item 11
NCW	input, item 11
NTAC	input, item 13
NUNI	input, item 13

Table II-16.- Continued.

PCX(I)	X coordinate of the control point associated with the i^{th} vortex on the wing
PHI(I)	dihedral angle, ϕ_i, in radians associated with the i^{th} vortex on the wing
PHID(I)	input, item 12
PSIWLE(I)	input, item 12
PSIWTE(I)	input, item 12
PTLX(I)	X coordinate of the 3/4 chord of the left side of the area element associated with the i^{th} vortex on the wing
PTLY(I)	Y coordinate of the 3/4 chord of the left side of the area element associated with the i^{th} vortex on the wing
PTLZ(I)	Z coordinate of the 3/4 chord of the left side of the area element associated with the i^{th} vortex on the wing
PVX(I)	X coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVY(I)	Y coordinate of the bound-leg midpoint of the i^{th} wing vortex
PVZ(I)	Z coordinate of the bound-leg midpoint of the i^{th} wing vortex
SINPHI(I)	$\sin \phi_i$ of the i^{th} wing vortex
SPAN	wing span
SREF	area of incompressible wing
SSPAN	semispan of wing; input, item 10
SUMY(I)	Y location of the midspan of the $(I - 1)^{th}$ wing segment
SW(I)	semispan, s, of the i^{th} wing vortex
SWPC(I)	tangent of the sweep angle of the 3/4 chord line of the area element associated with the i^{th} wing vortex measured in the planform plane
SWPV(I)	$\tan \psi_p$ of the i^{th} wing vortex

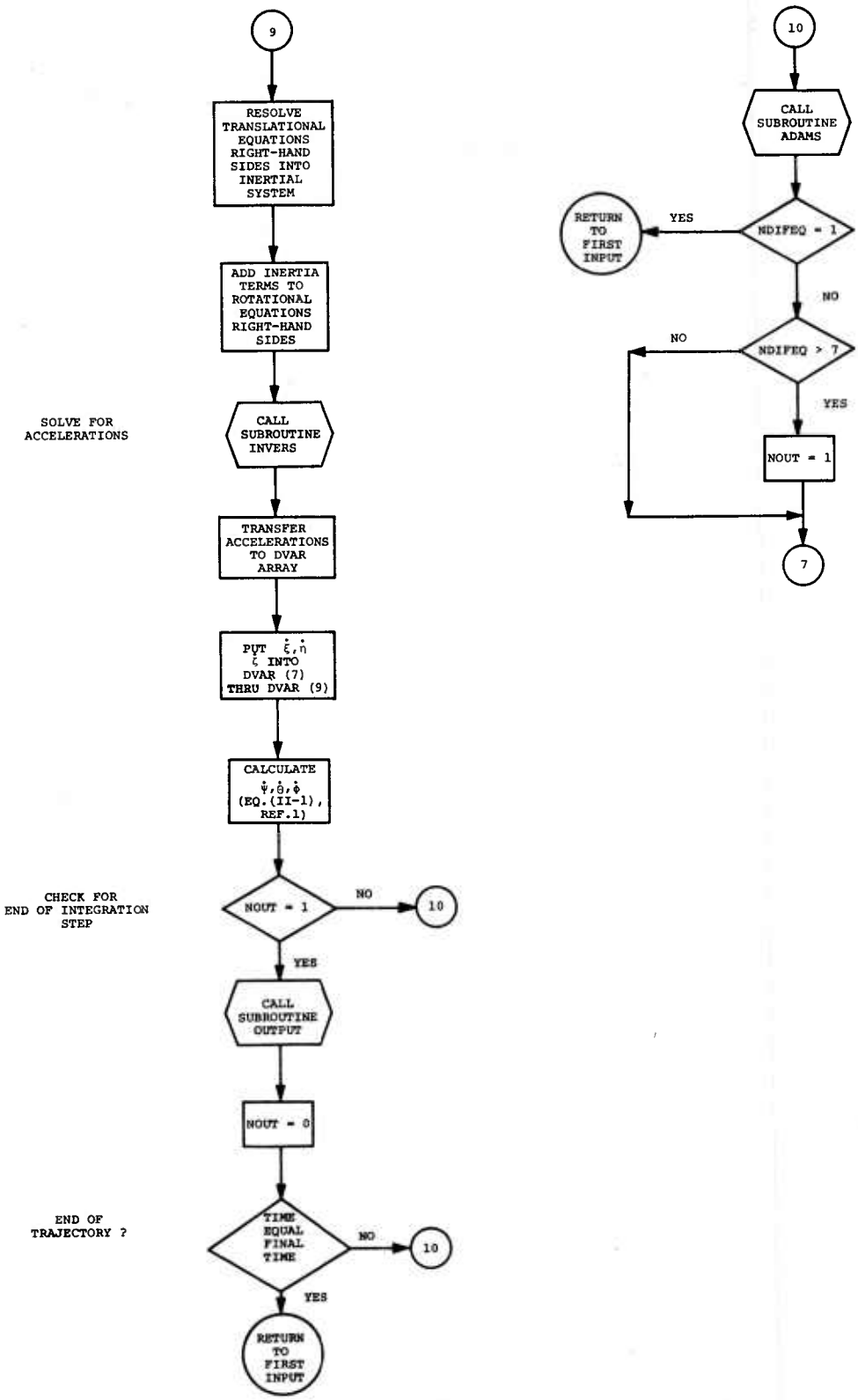
Table II-16.- Concluded.

SWPVV(I)	tan ψ of the i^{th} wing vortex
SWPWLI(I)	tangent of the leading-edge sweep angle in incompressible space of the $(I - 1)^{th}$ wing segment
SWPWTI(I)	tangent of the trailing-edge sweep angle in incompressible space of the $(I - 1)^{th}$ wing segment
TANPHI(I)	tan ϕ_i of the $(I - 1)^{th}$ wing segment
XLEL(I)	X coordinate of wing leading edge at Y = Y(I)
Y(I)	input, item 12
YLOC(I)	SUMY(I)/SSPAN
ZLEL(I)	Z coordinate of wing leading edge at Y = Y(I)



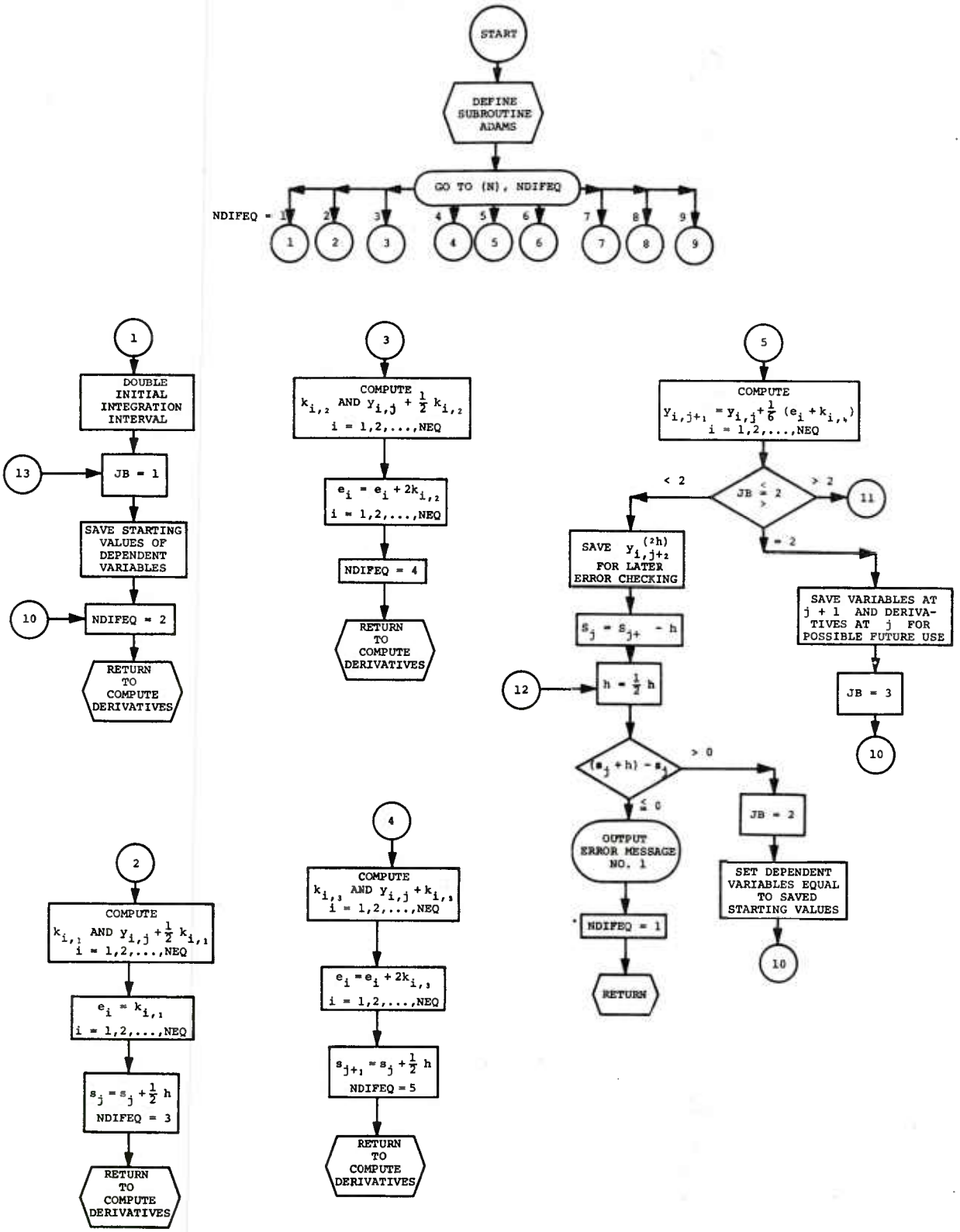
(a) Page 1.

Figure II-1.- Flow chart of integration loop of main program.



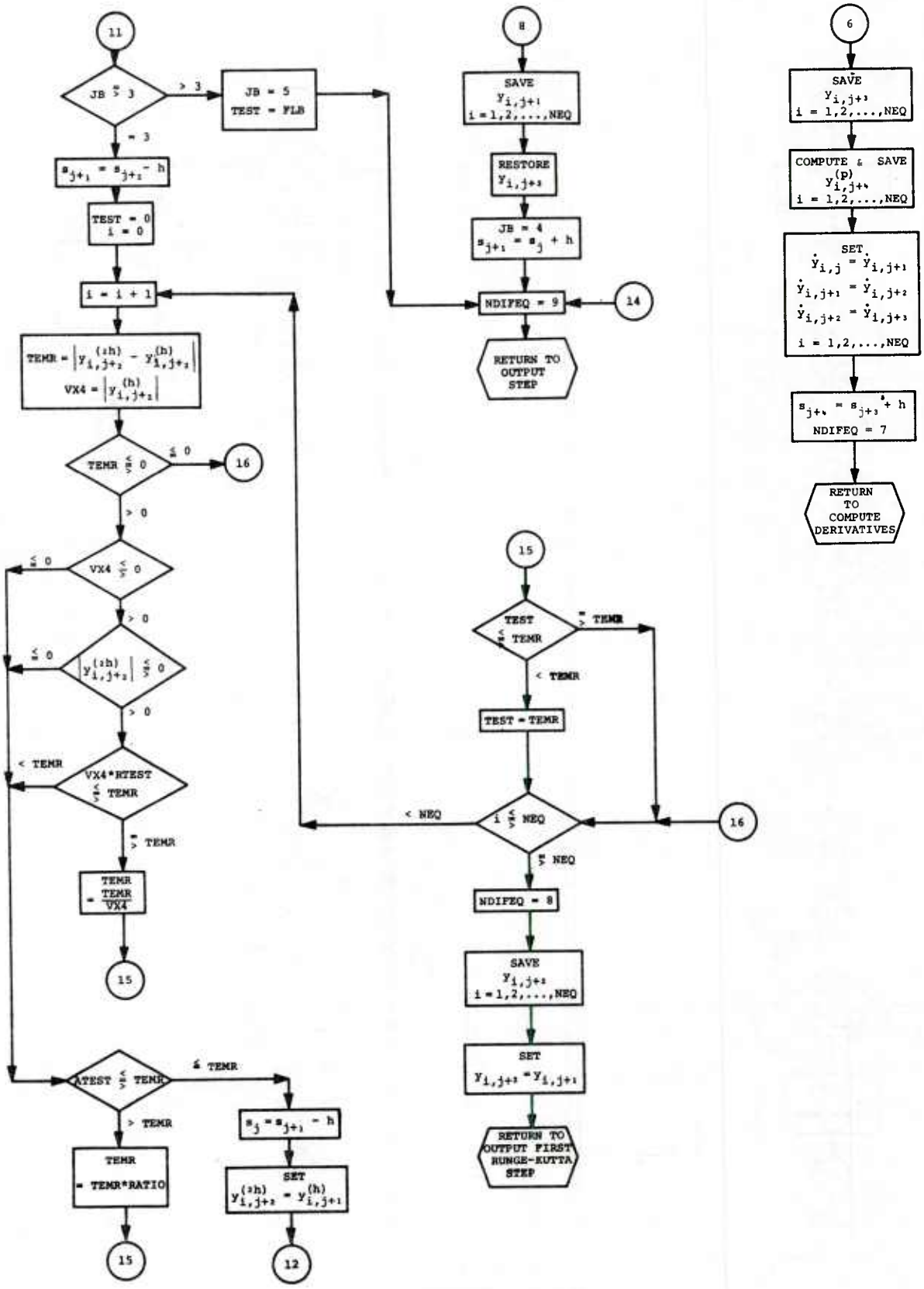
(b) Page 2.

Figure II-1.- Concluded.



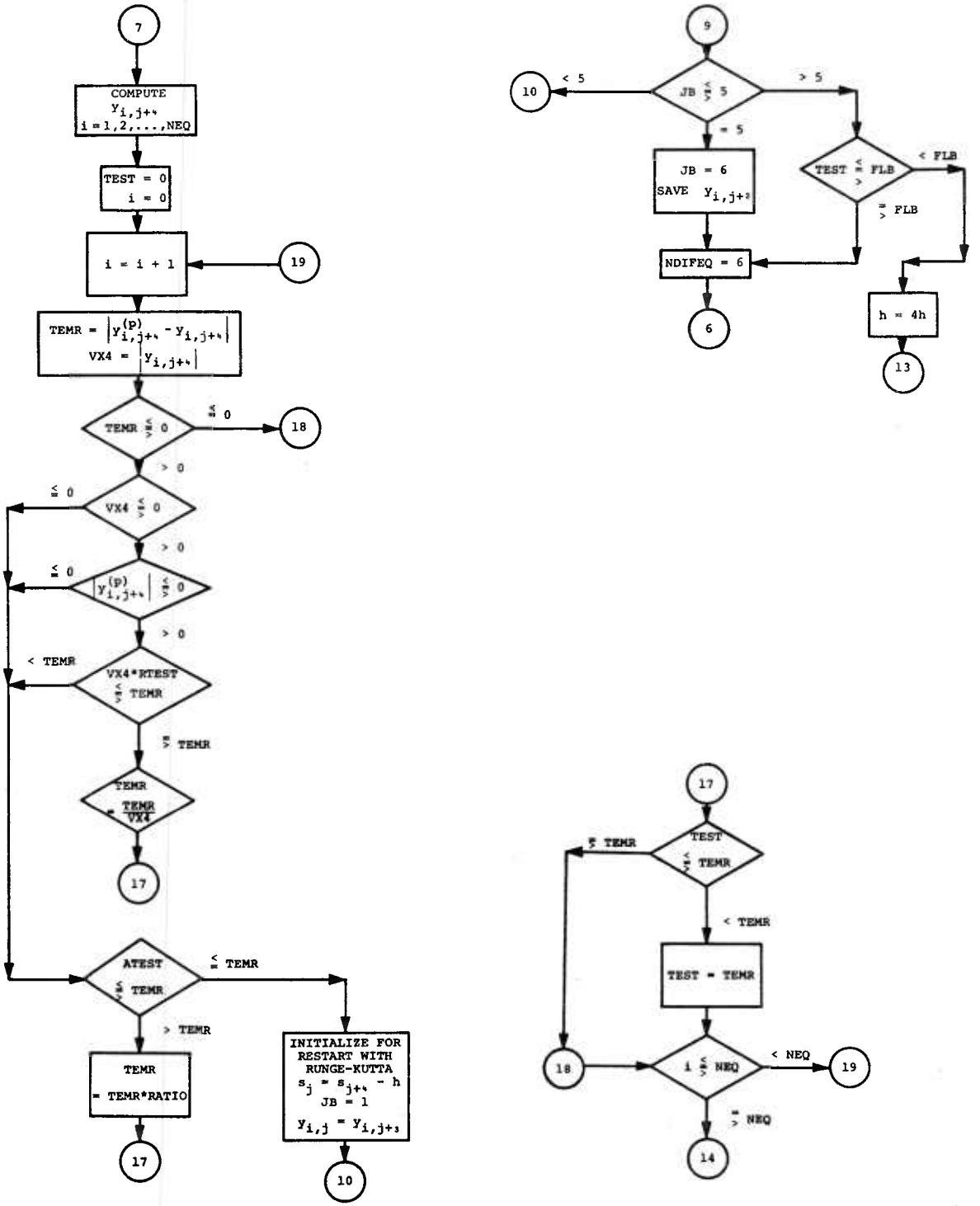
(a) Page 1.

Figure II-2.- Flow chart of subroutine ADAMS.



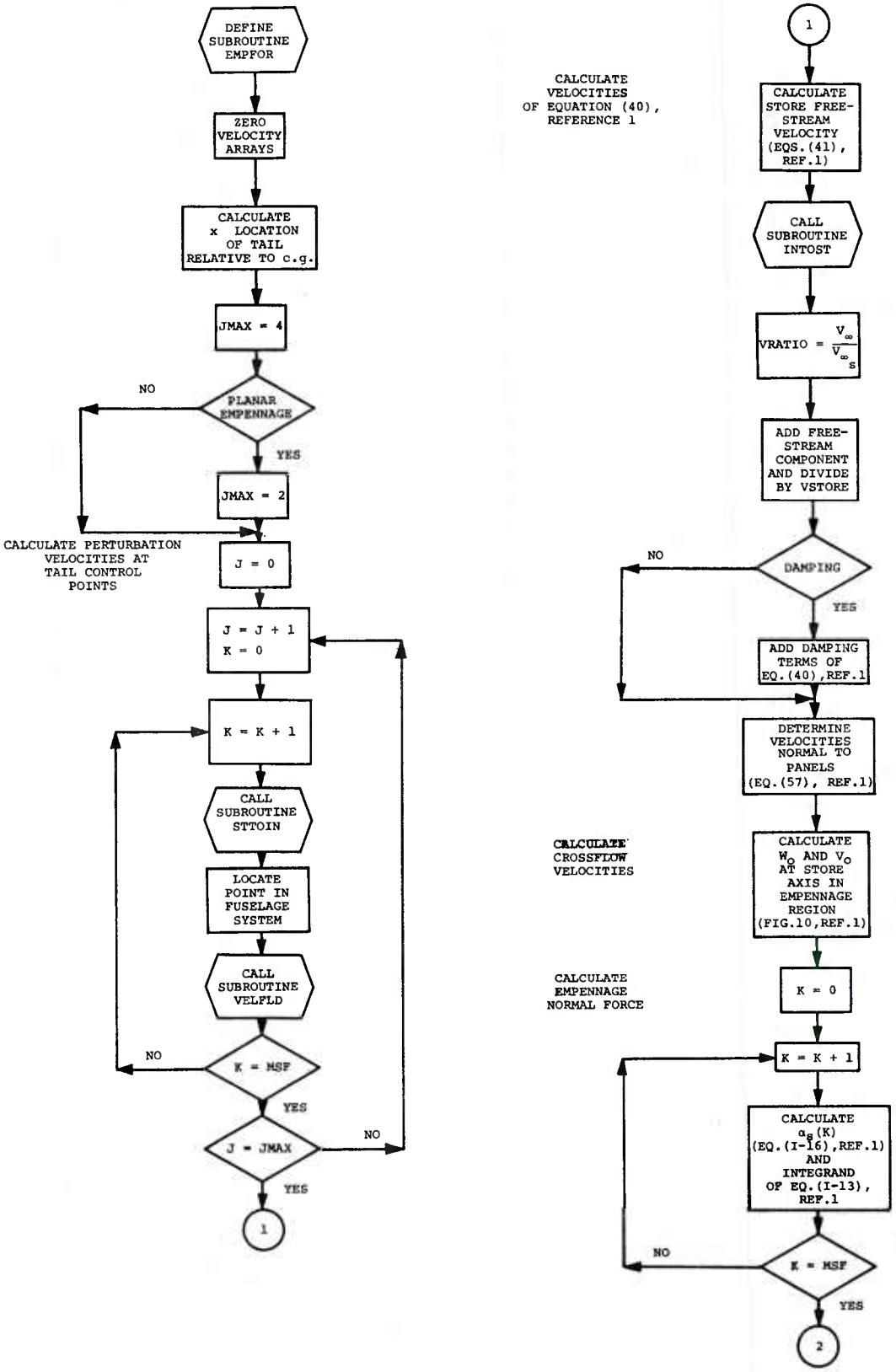
(b) Page 2.

Figure II-2.- Continued.



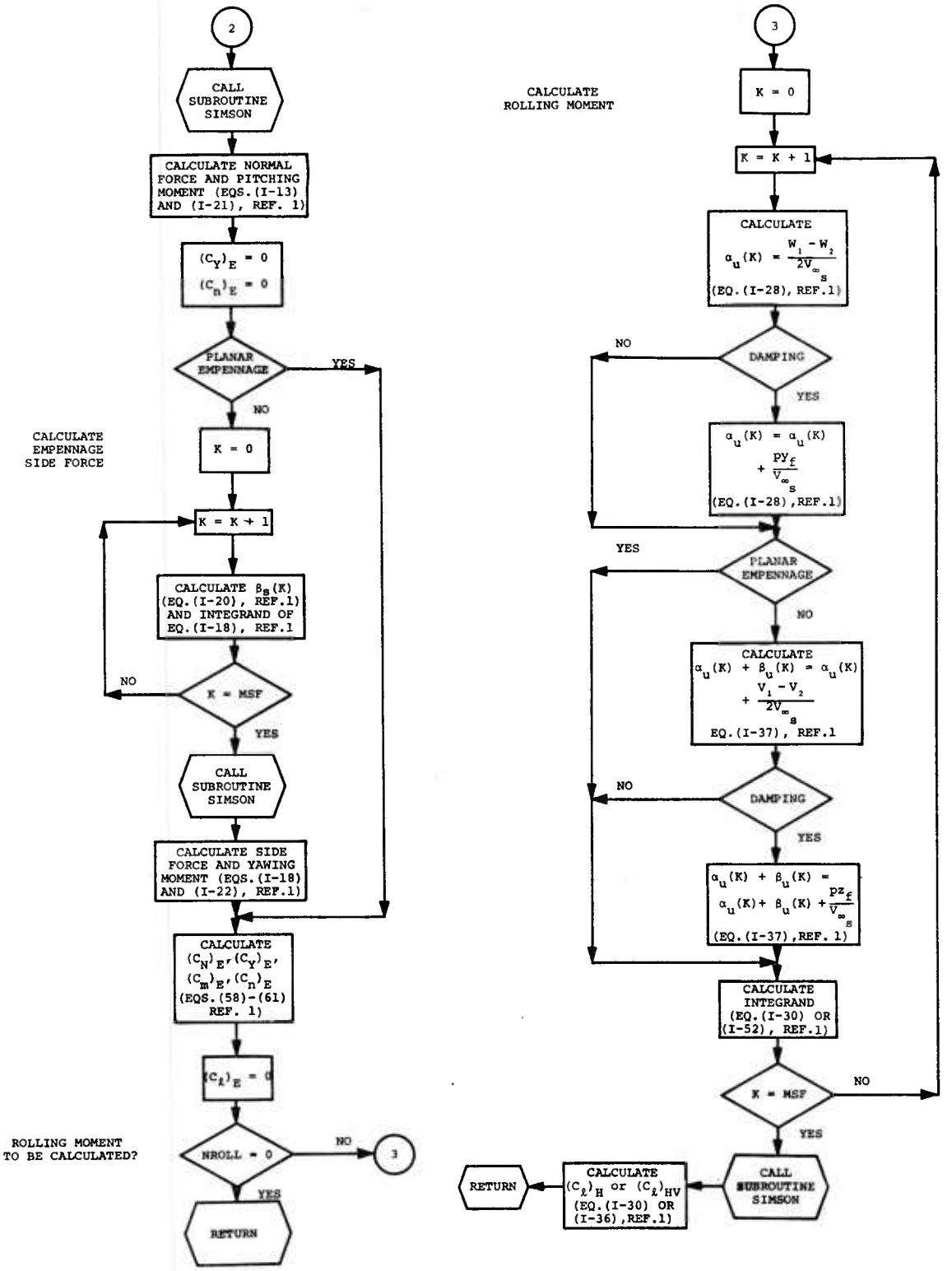
(c) Page 3.

Figure II-2.- Concluded.



(a) Page 1.

Figure II-3.- Flow chart of subroutine EMPFOR.



(b) Page 2.

Figure II-3.- Concluded.

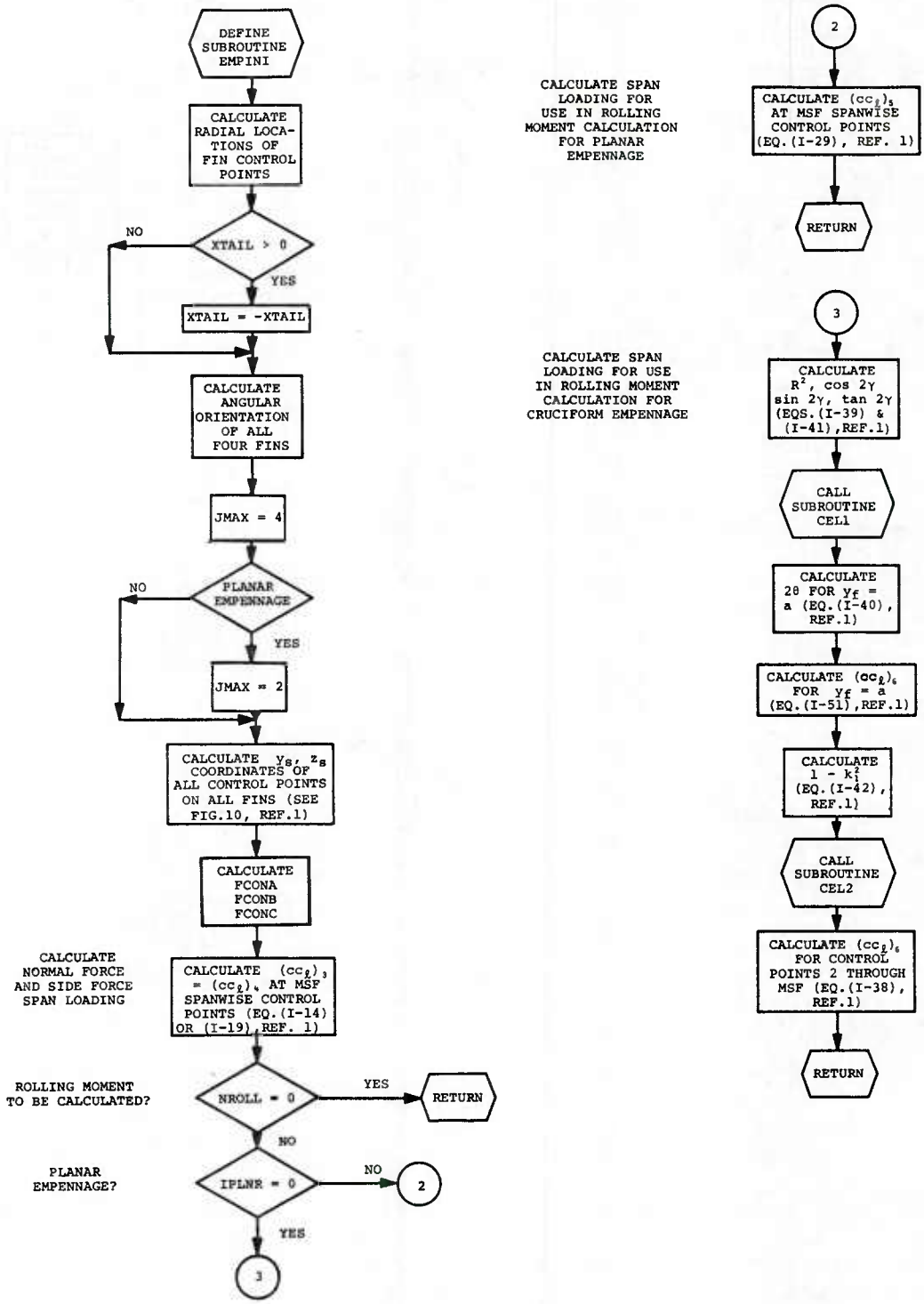
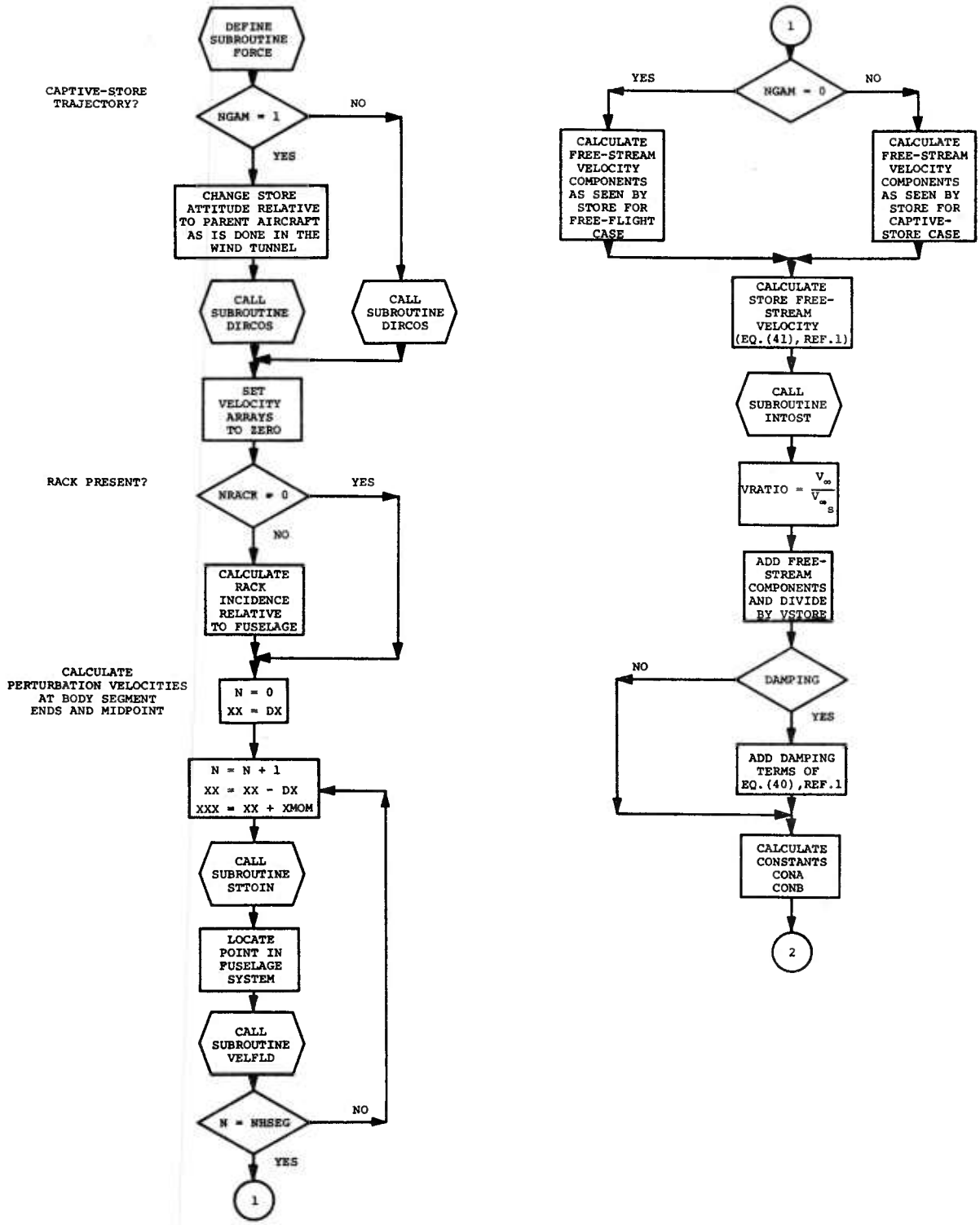
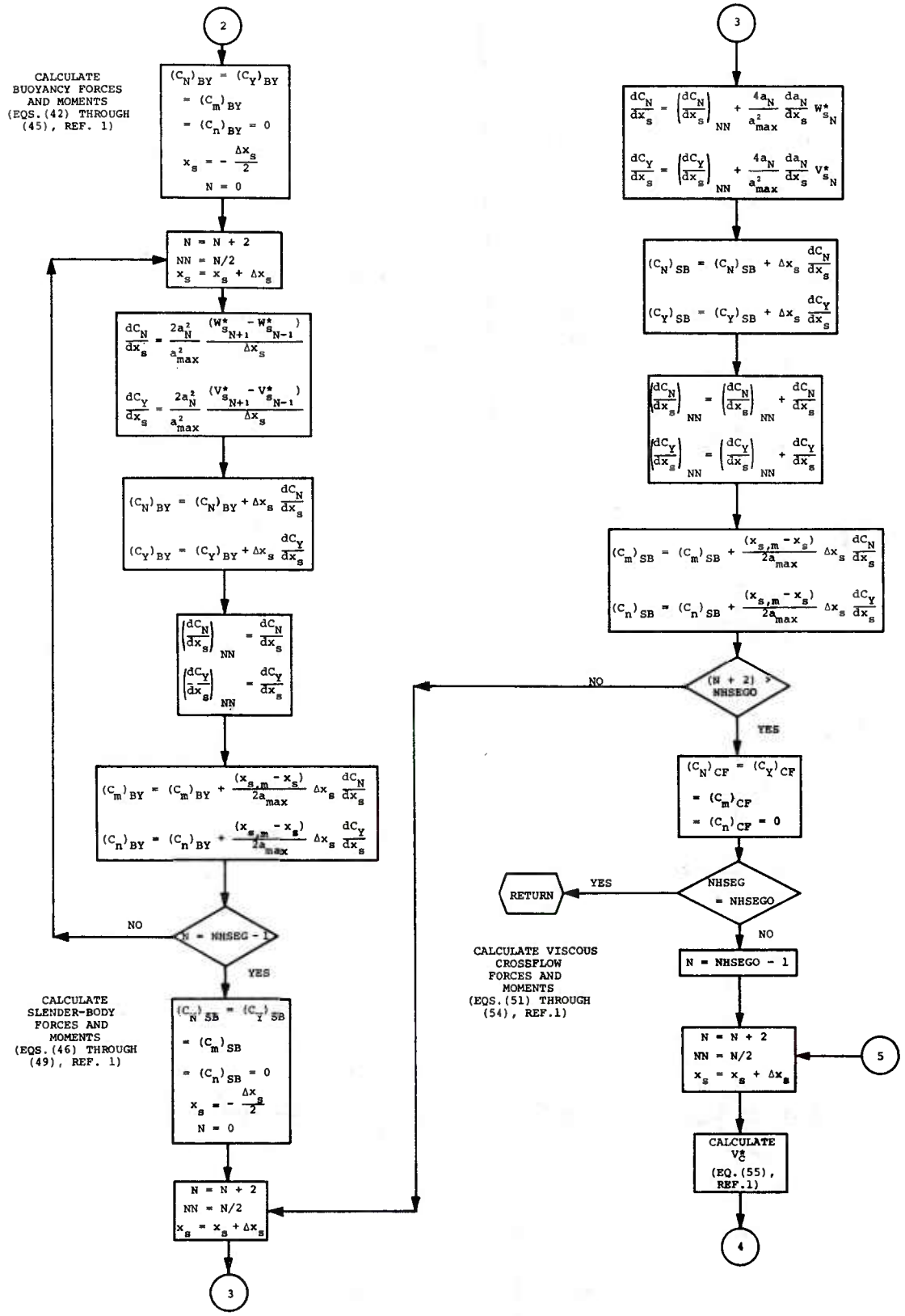


Figure II-4.- Flow chart of subroutine EMPINI.



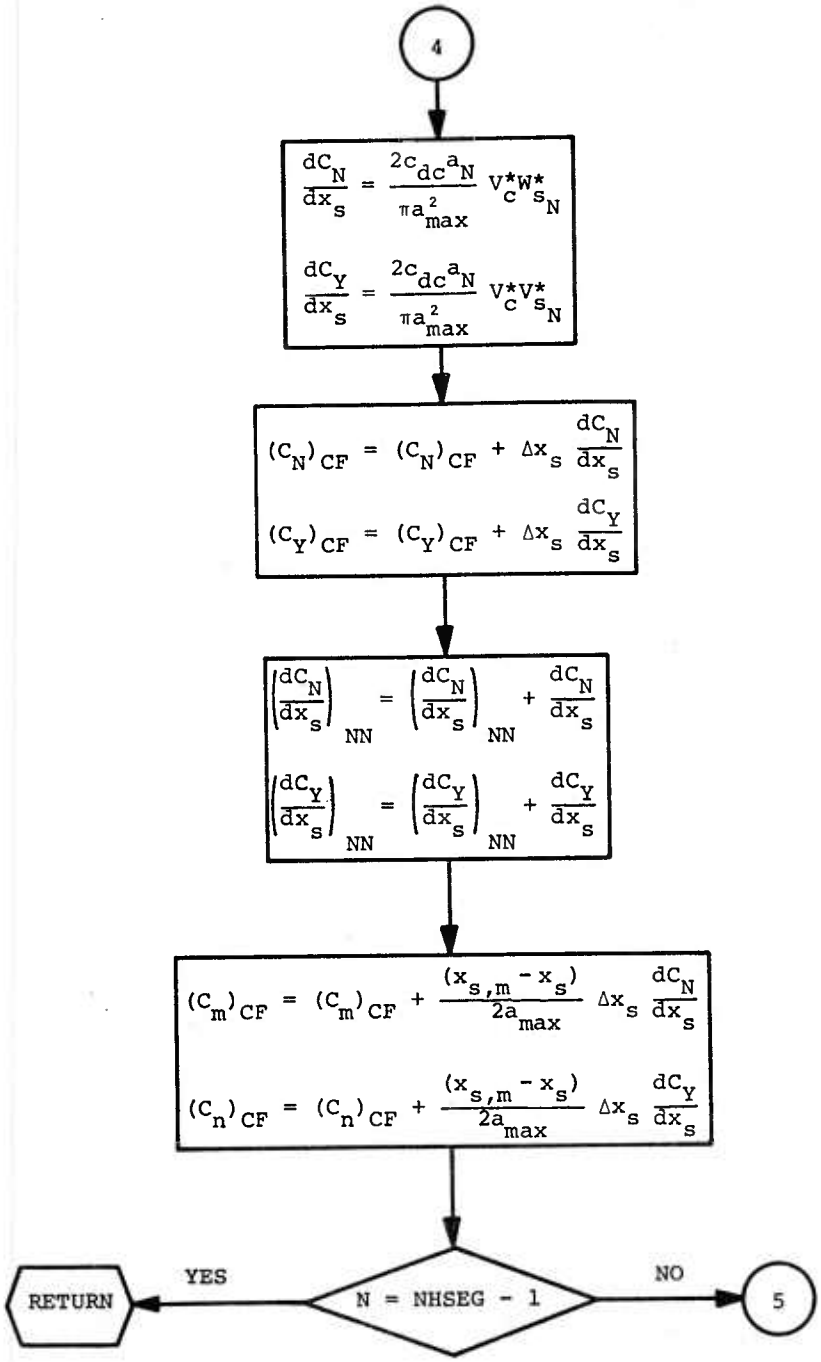
(a) Page 1.

Figure II-5.- Flow chart of subroutine FORCE.



(b) Page 2.

Figure II-5.- Continued.



(c) Page 3.

Figure II-5.- Concluded.

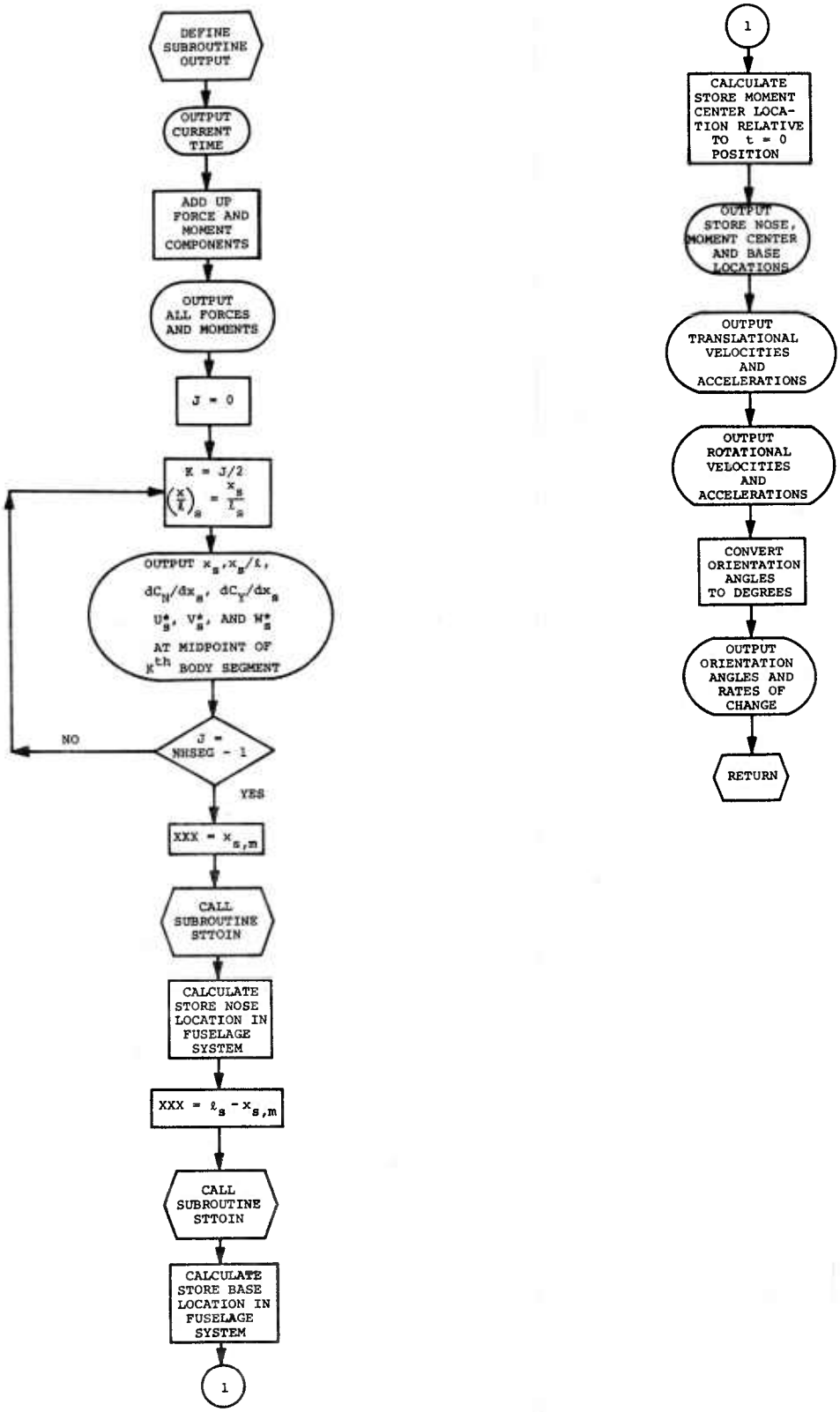


Figure II-6.- Flow chart of subroutine OUTPUT.

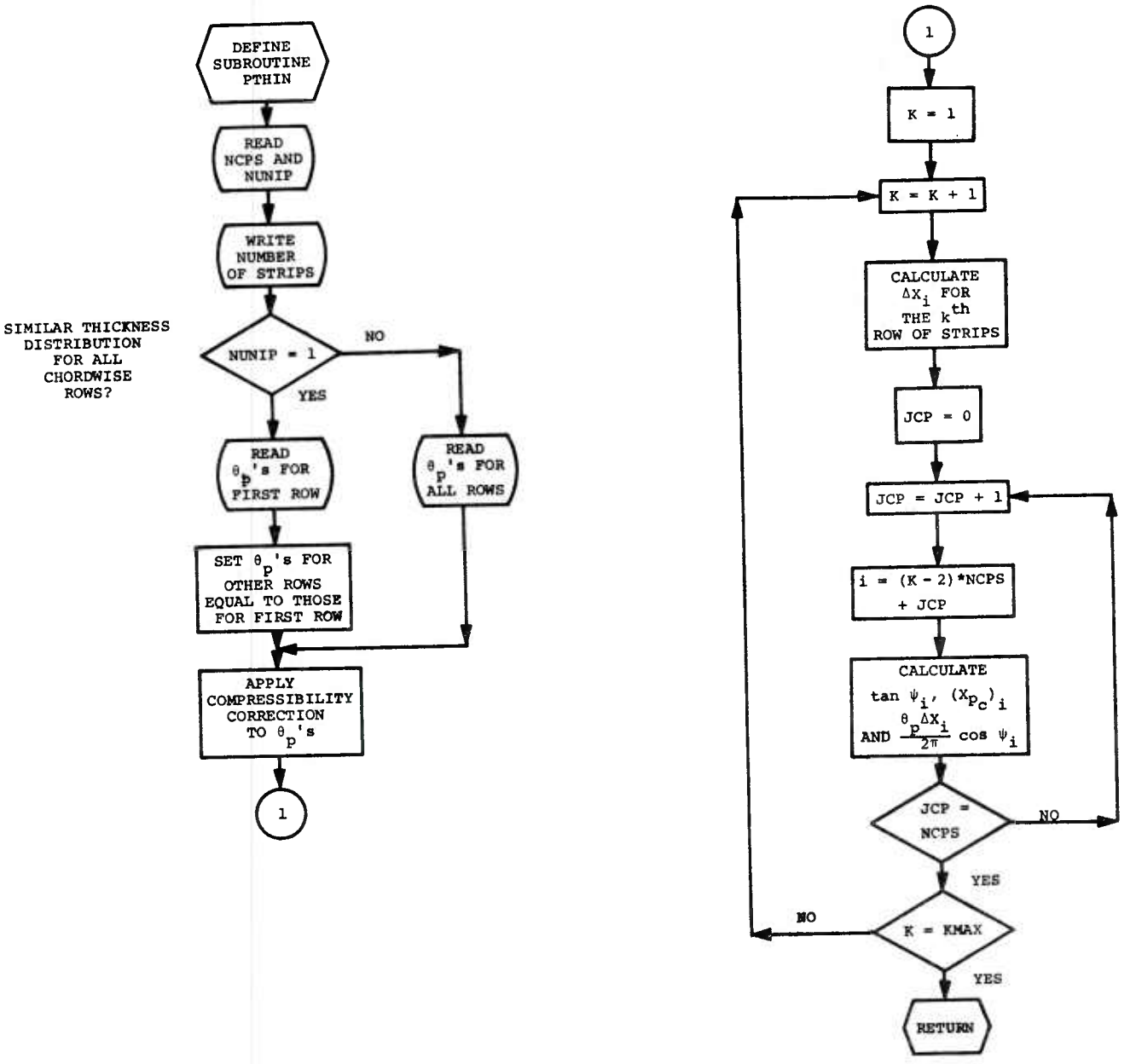


Figure II-7.- Flow chart of subroutine PTHIN.

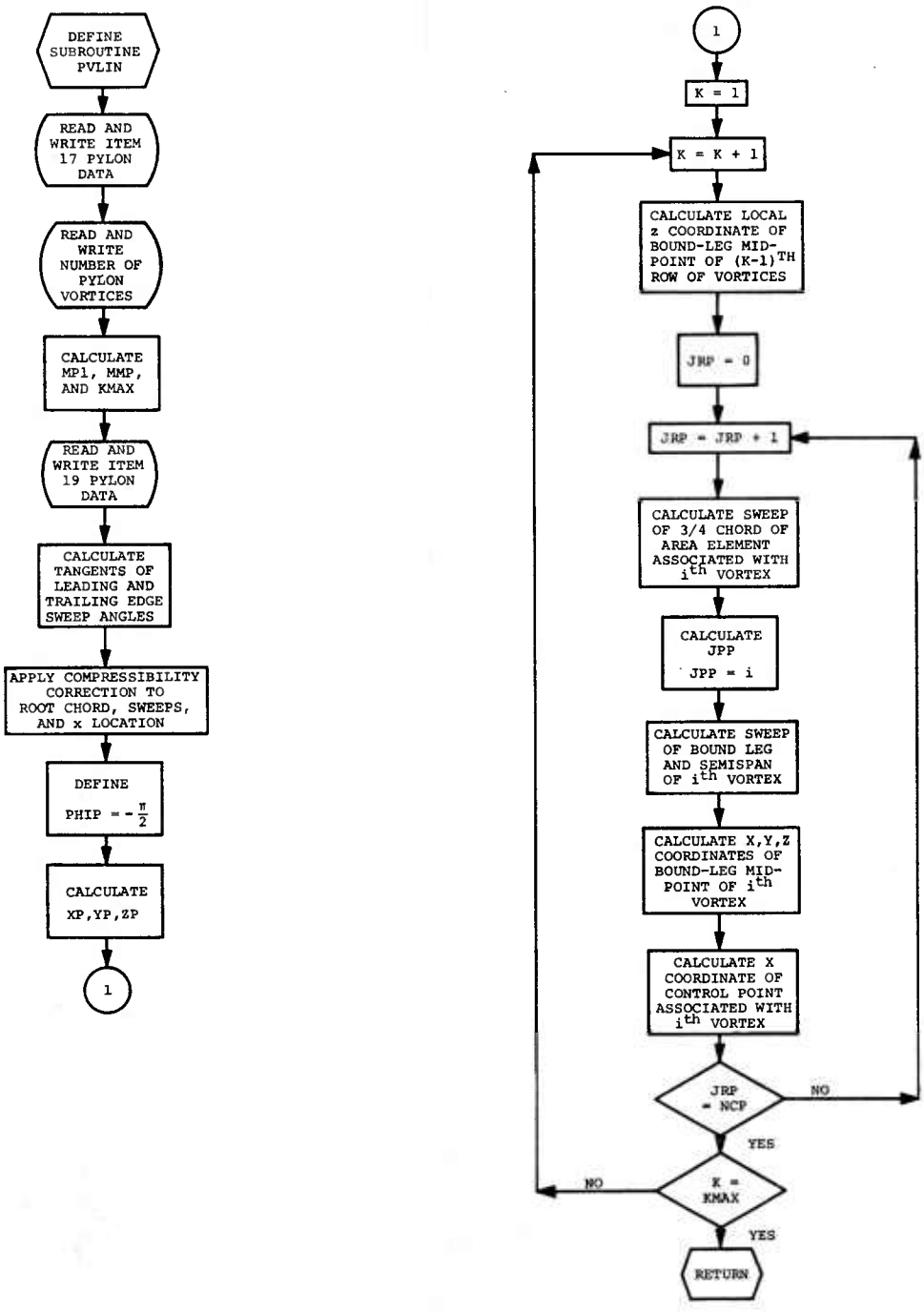


Figure II-8.- Flow chart of subroutine PVLIN.

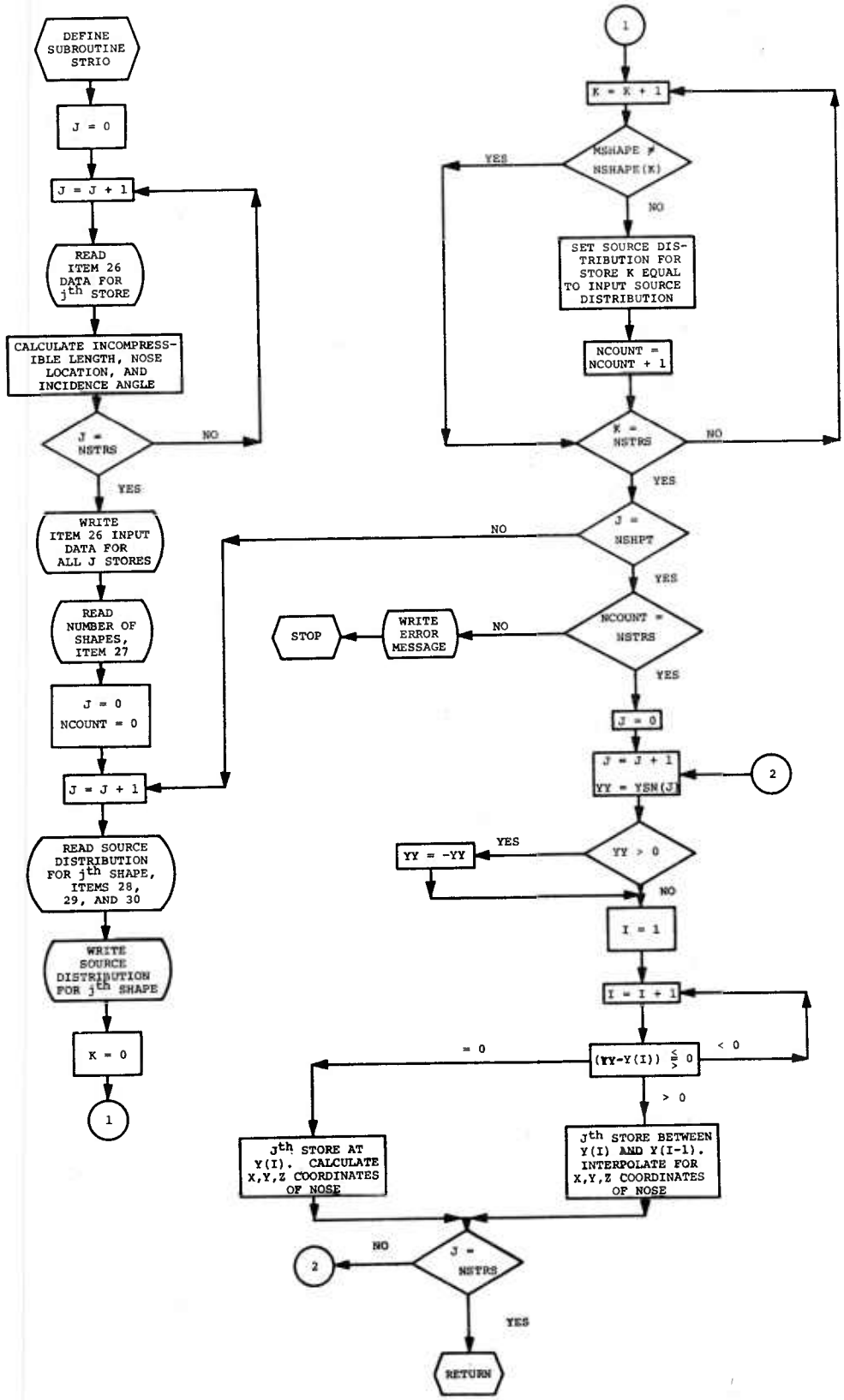


Figure II-9.- Flow chart of subroutine STRIO.

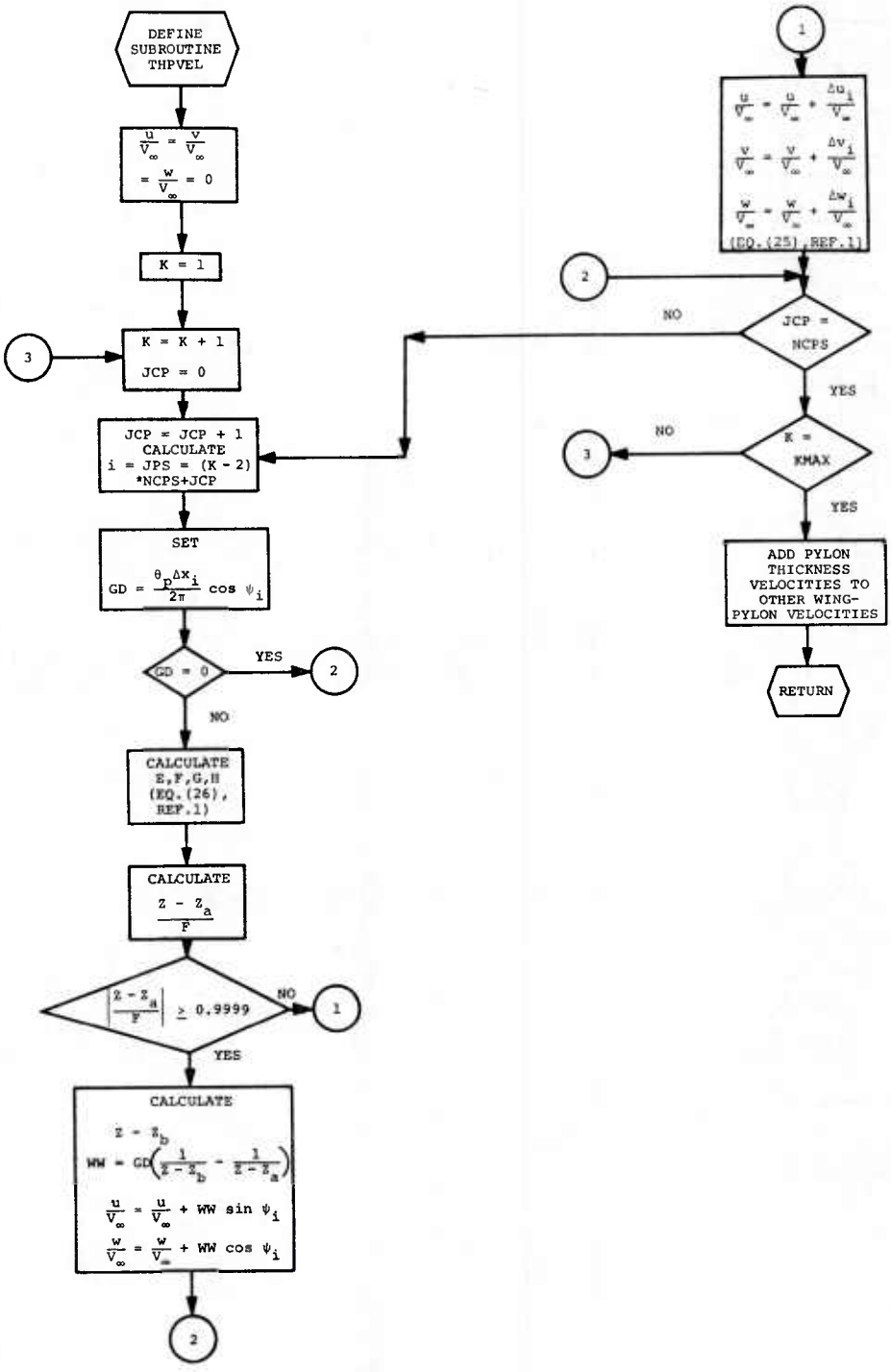


Figure II-10.- Flow chart of subroutine THPVEL.

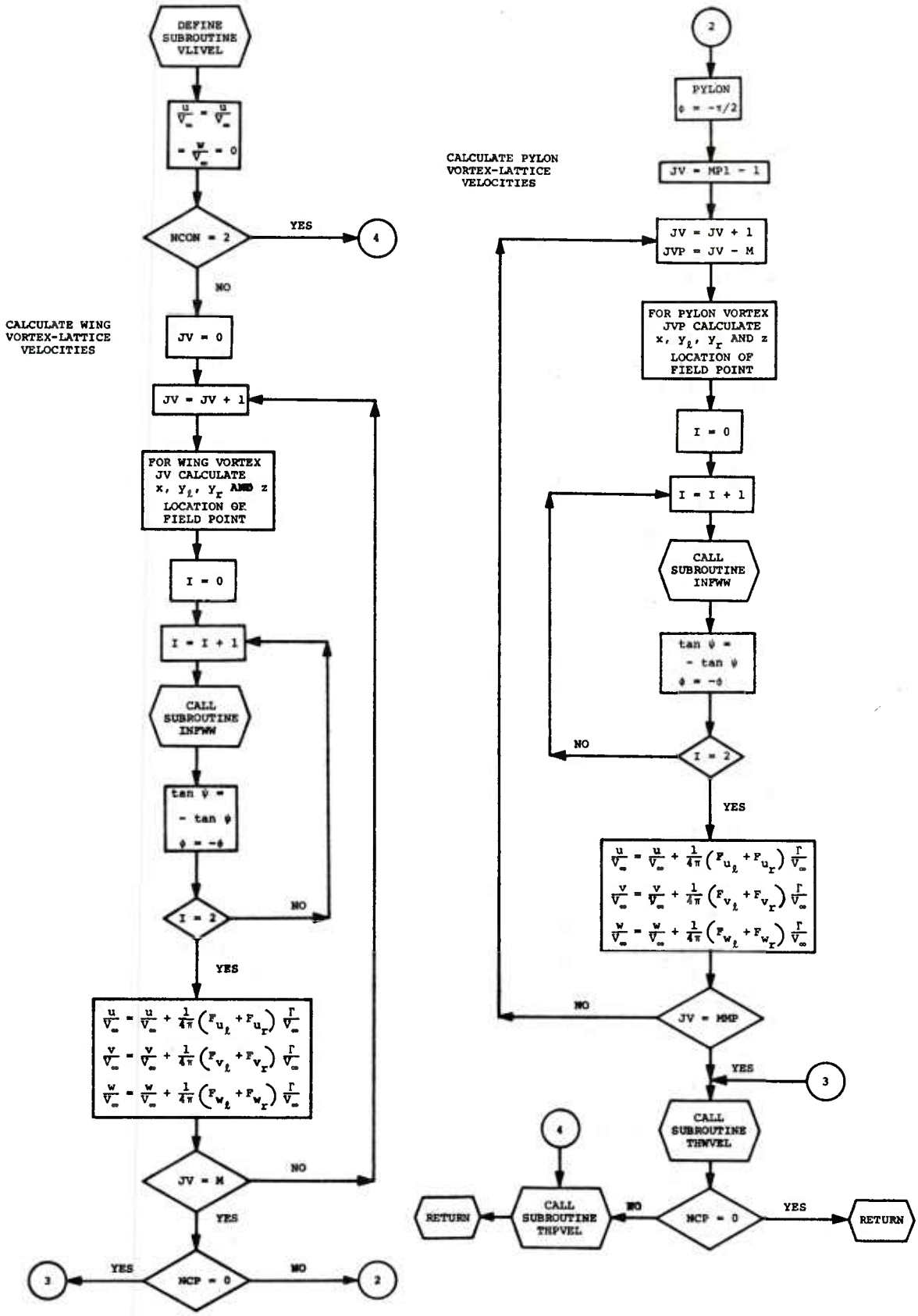
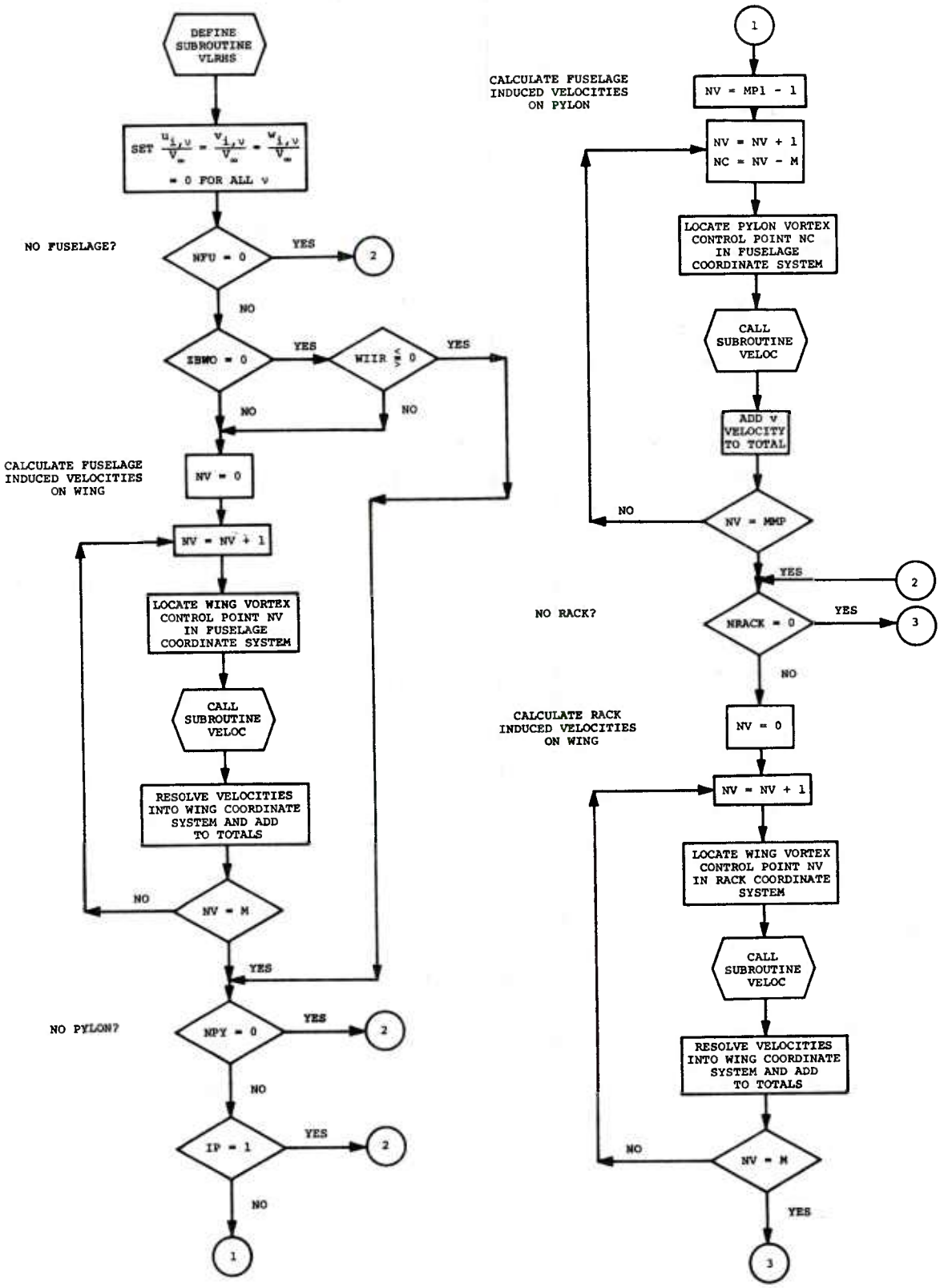
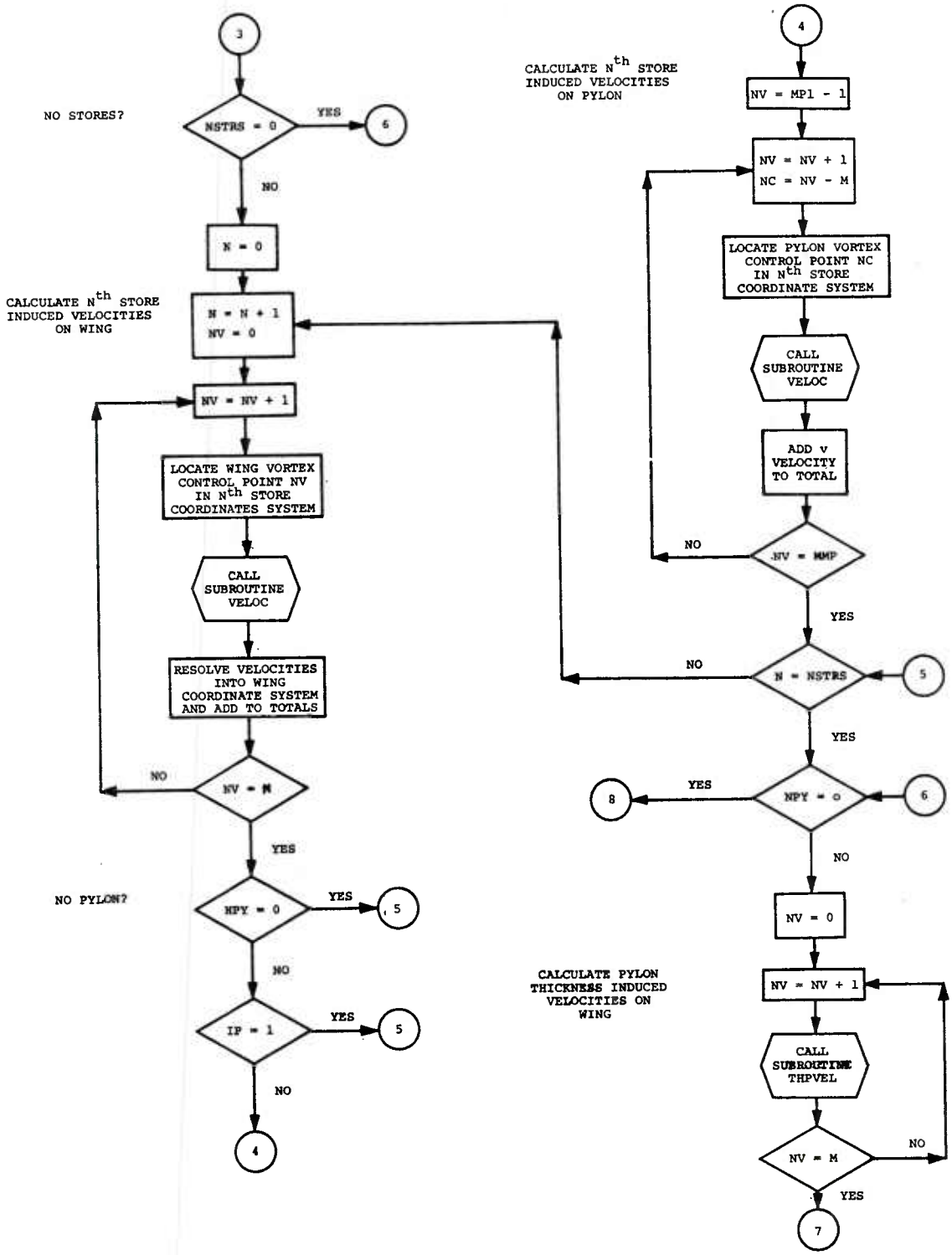


Figure II-15.- Flow chart of subroutine VLIVEL.



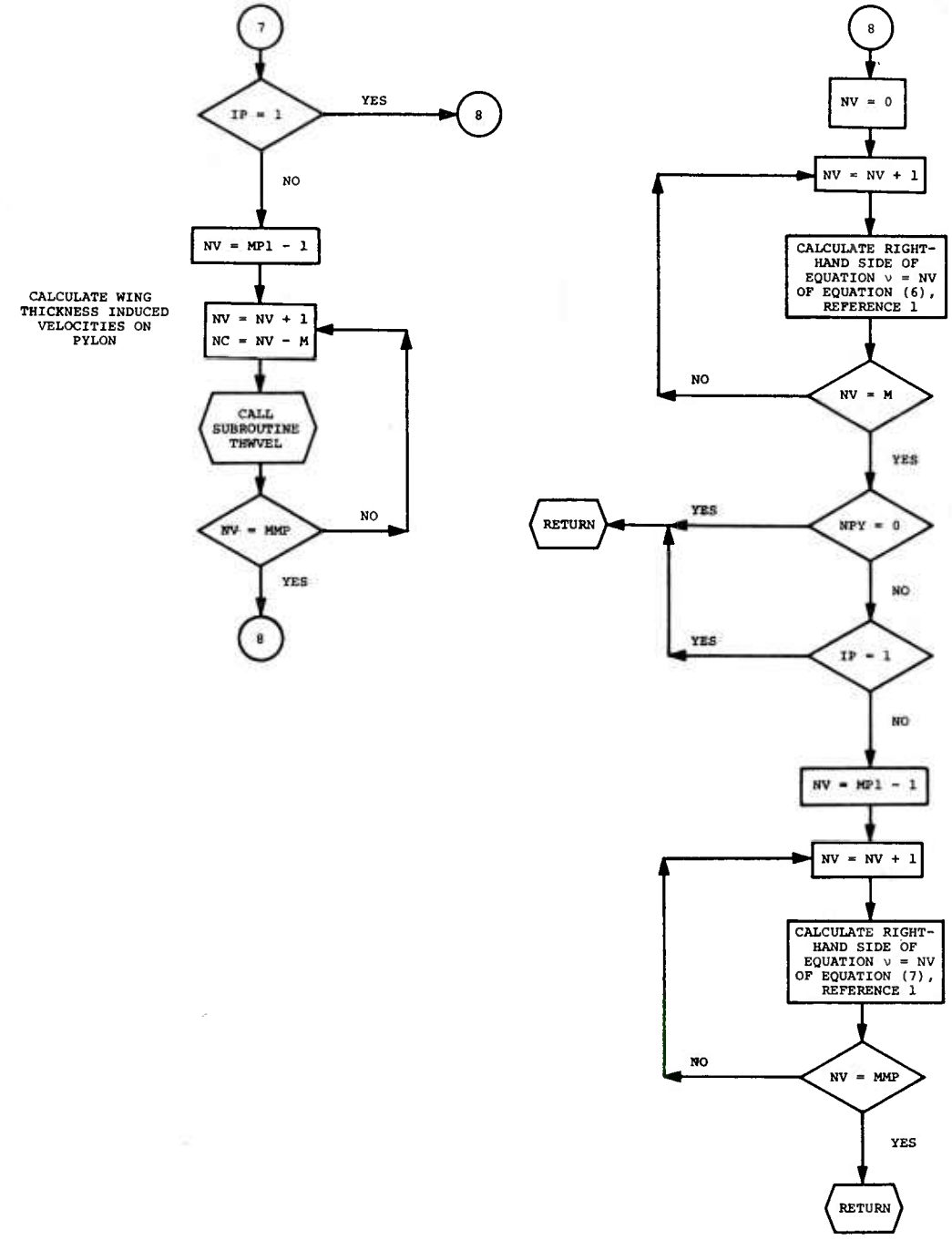
(a) Page 1.

Figure II-16.- Flow chart of subroutine VLRHS.



(b) Page 2.

Figure II-16.- Continued.



(c) Page 3.

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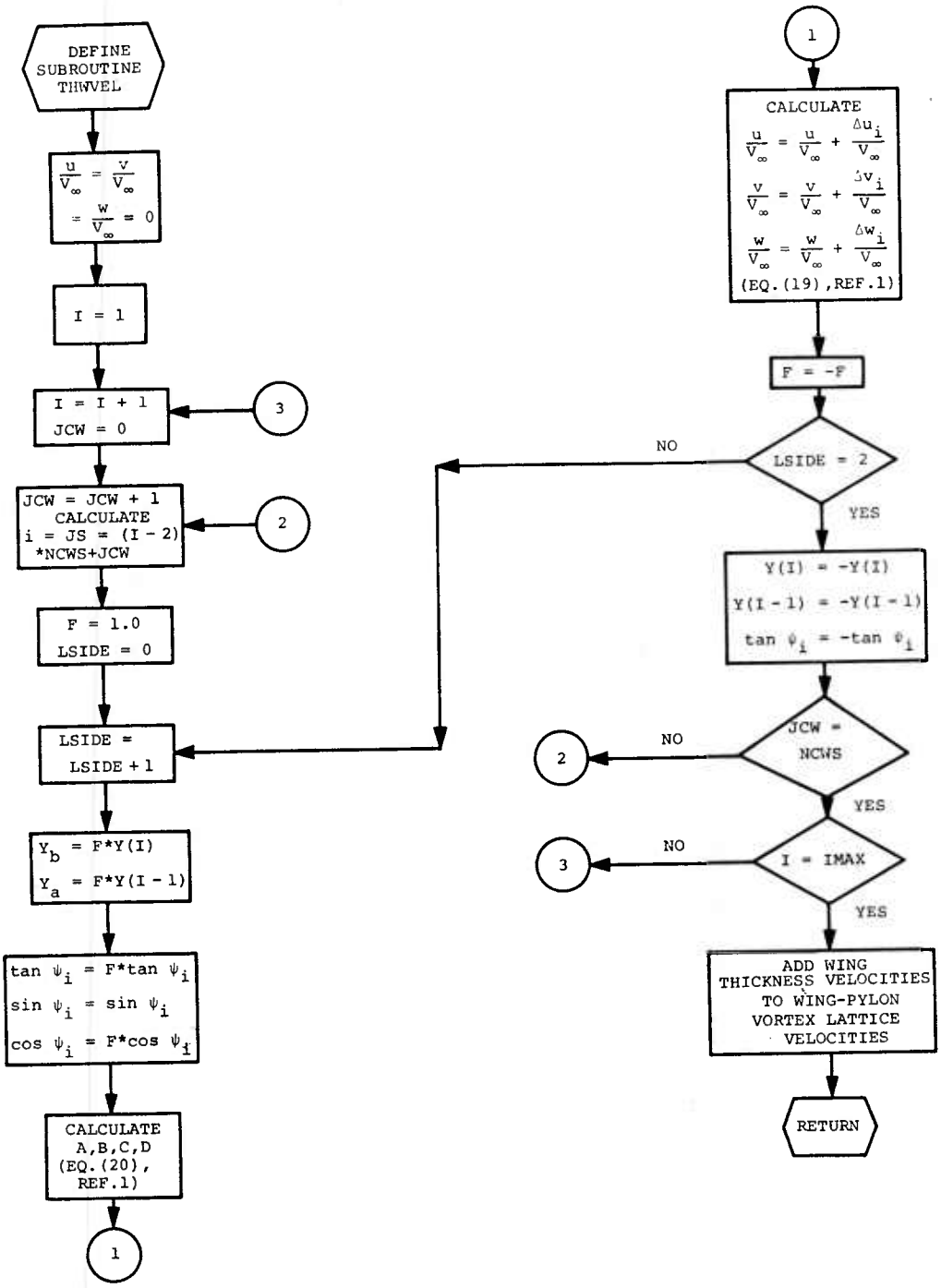
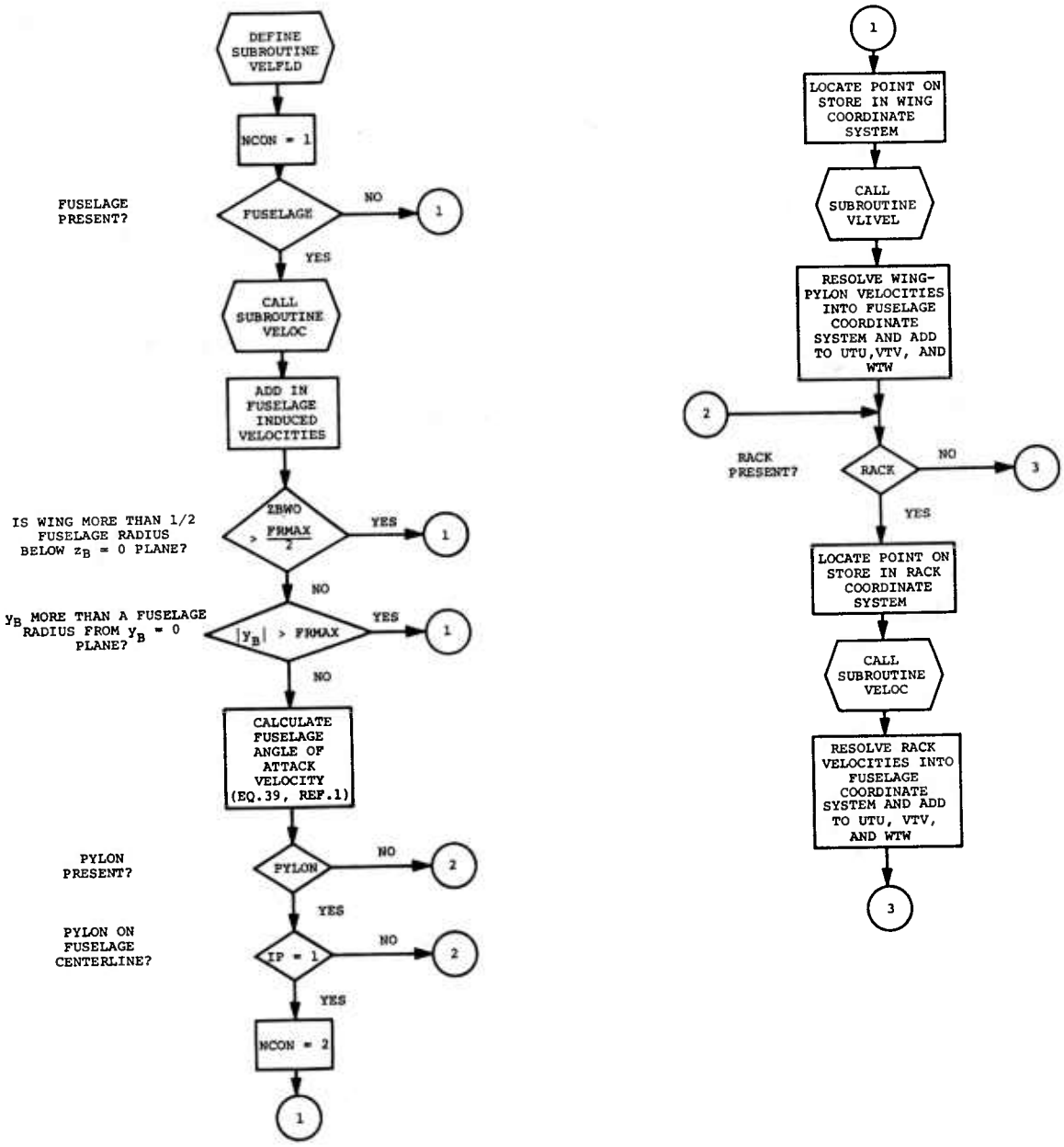
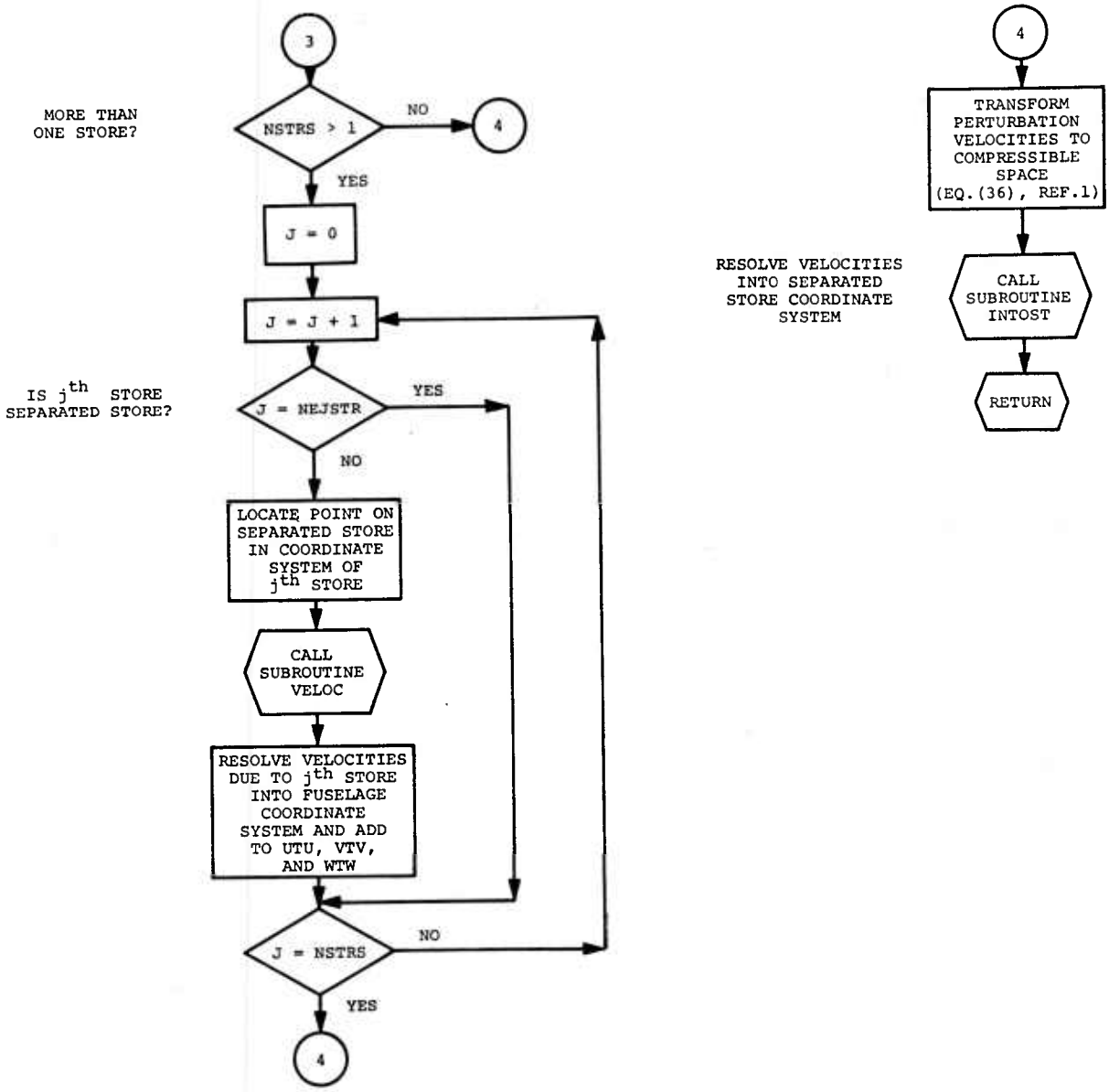


Figure II-11.- Flow chart of subroutine THWVEL.



(a) Page 1.

Figure II-12.- Flow chart of subroutine VELFLD.



(b) Page 2.

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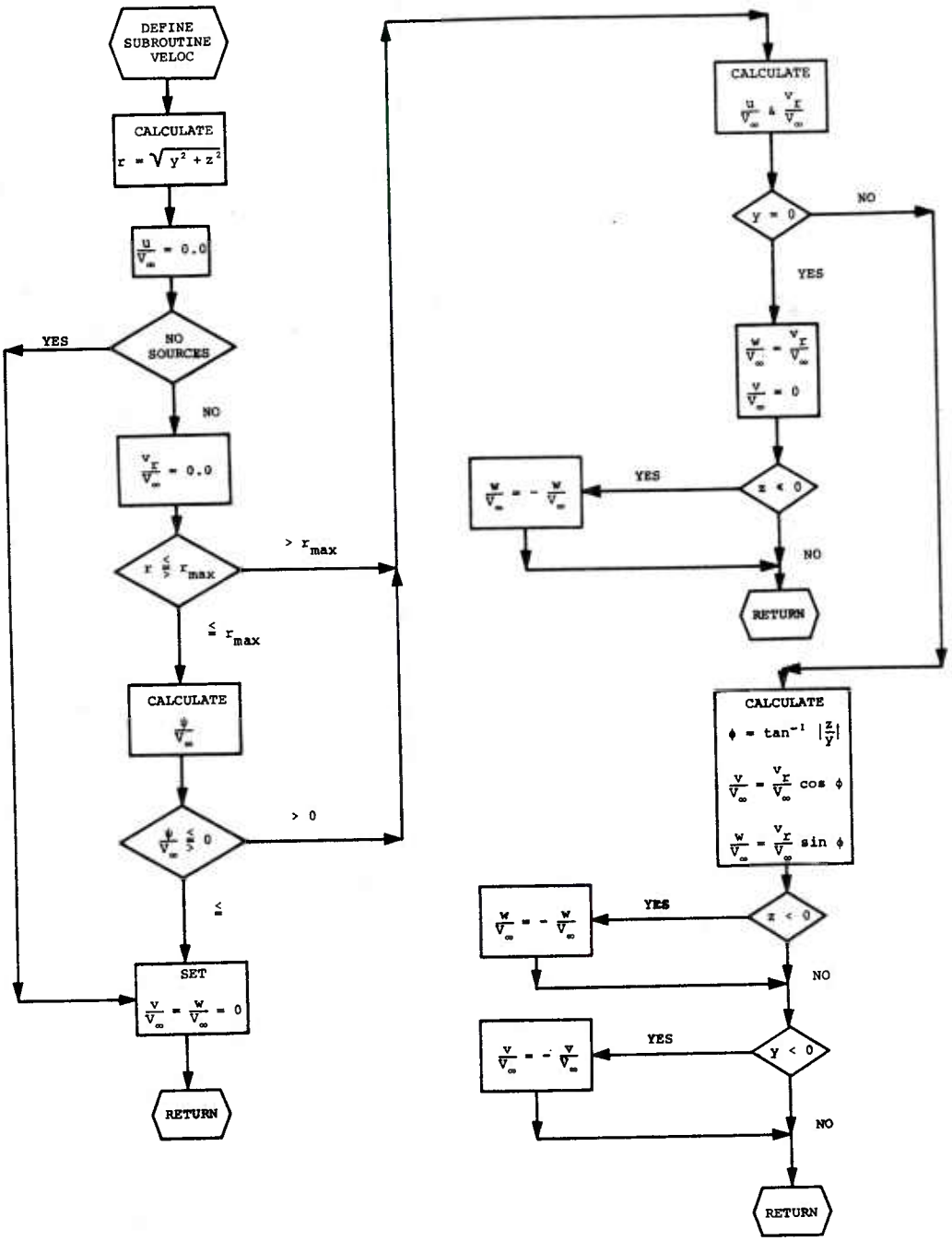
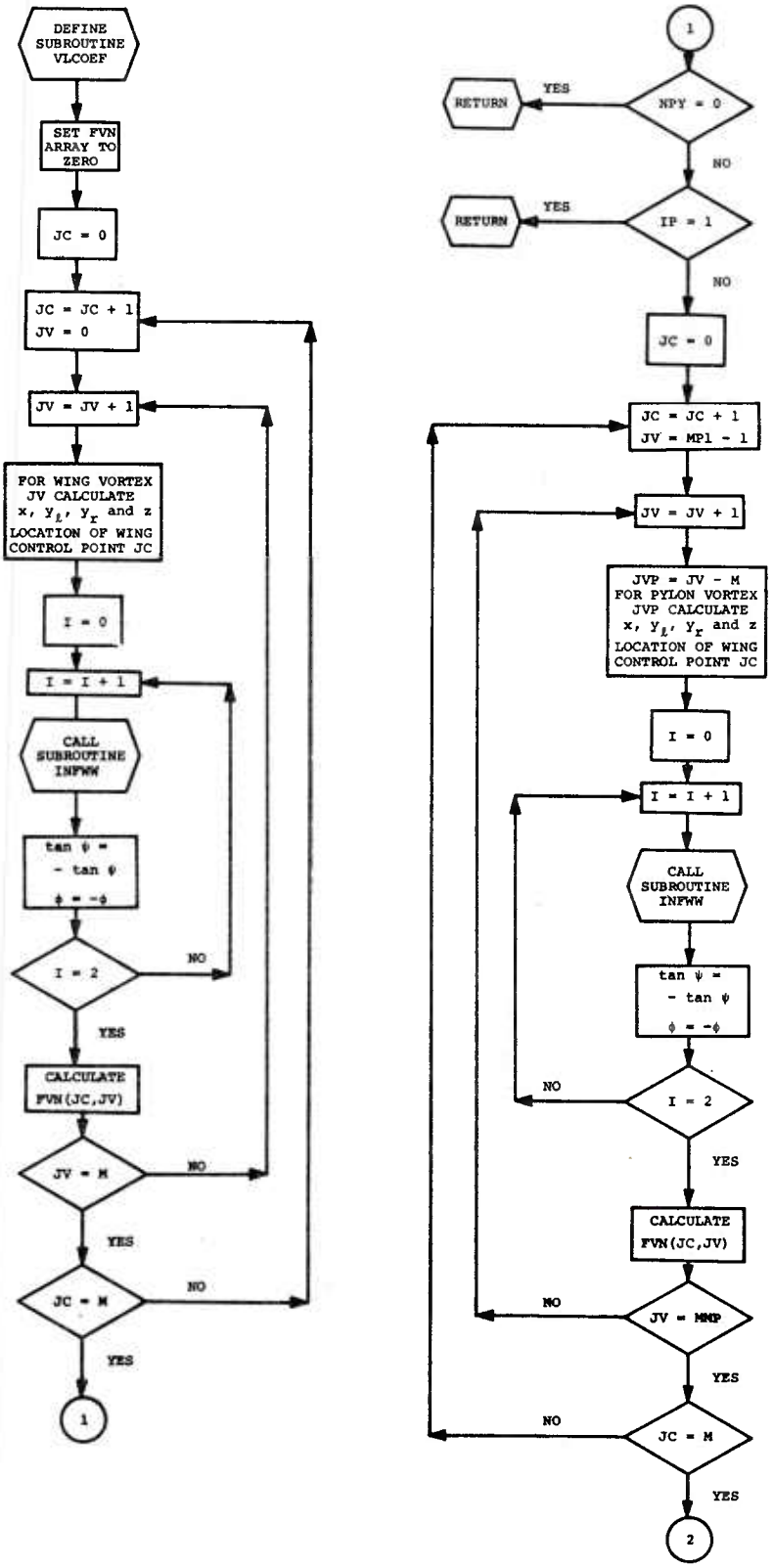
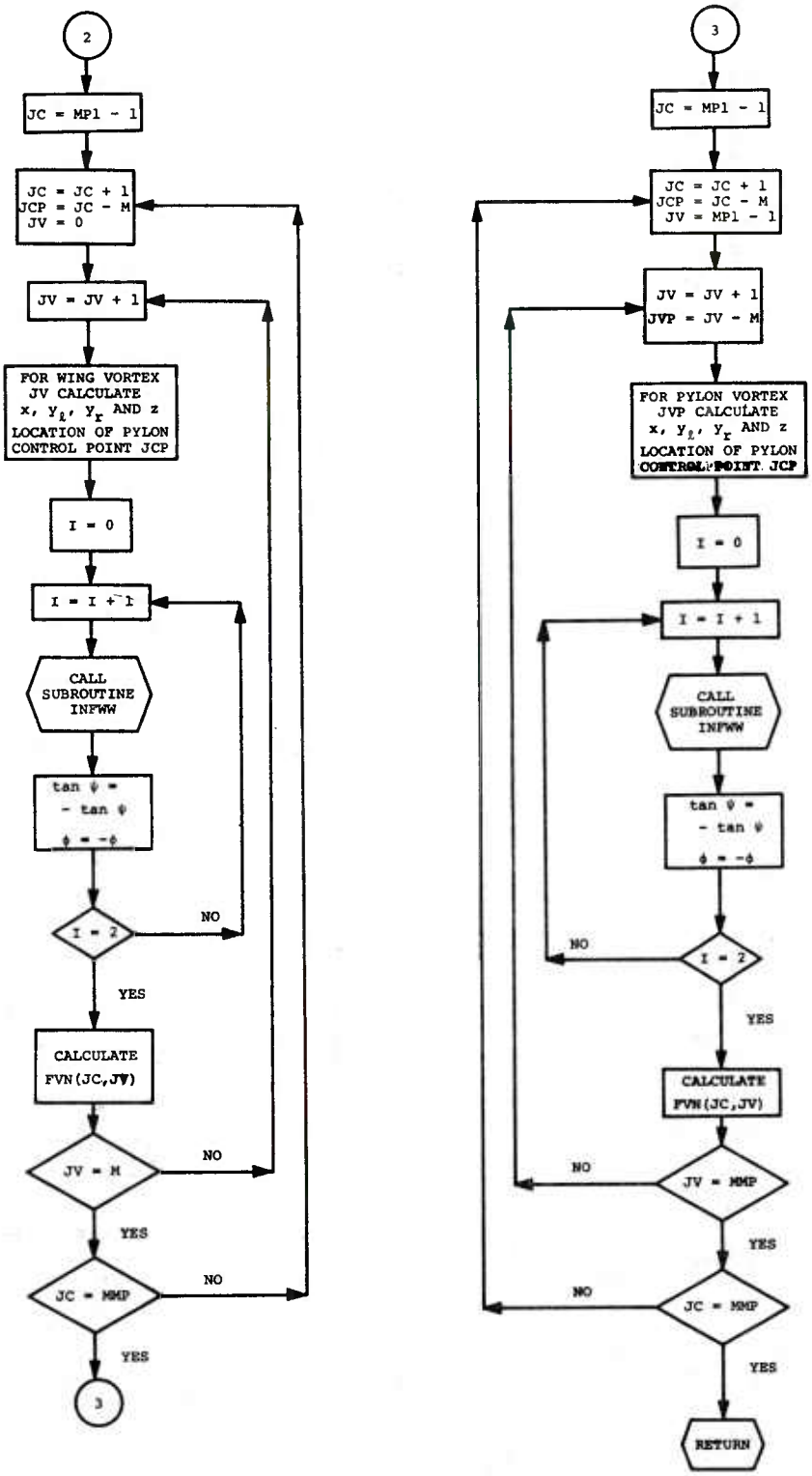


Figure II-13.- Flow chart of subroutine VELOC.



(a) Page 1.

Figure II-14.- Flow chart of subroutine VLCOEF.



(b) Page 2.

Figure II-14.- Concluded.

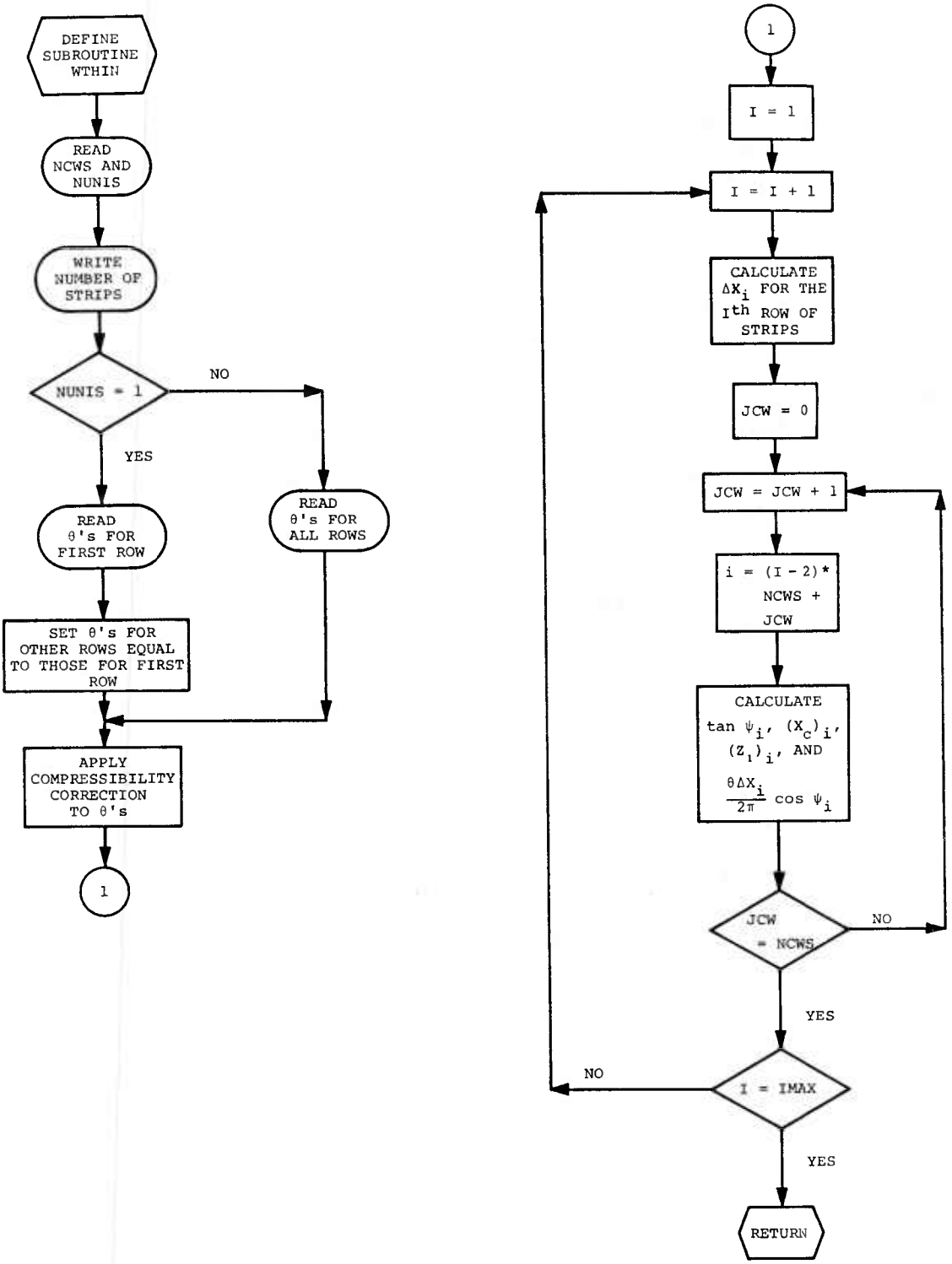
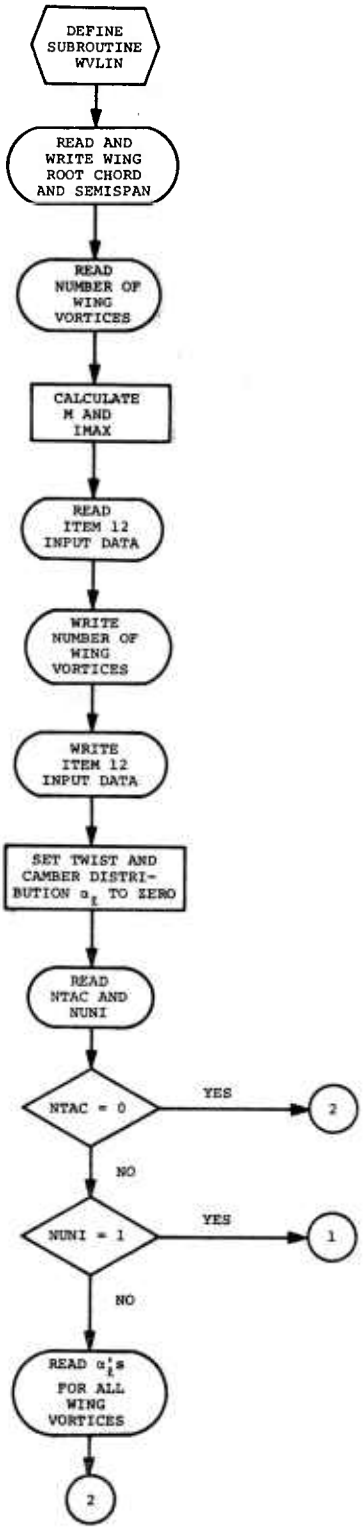
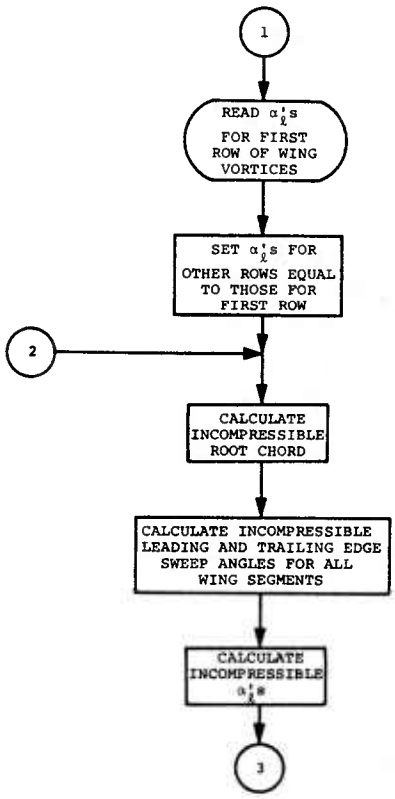


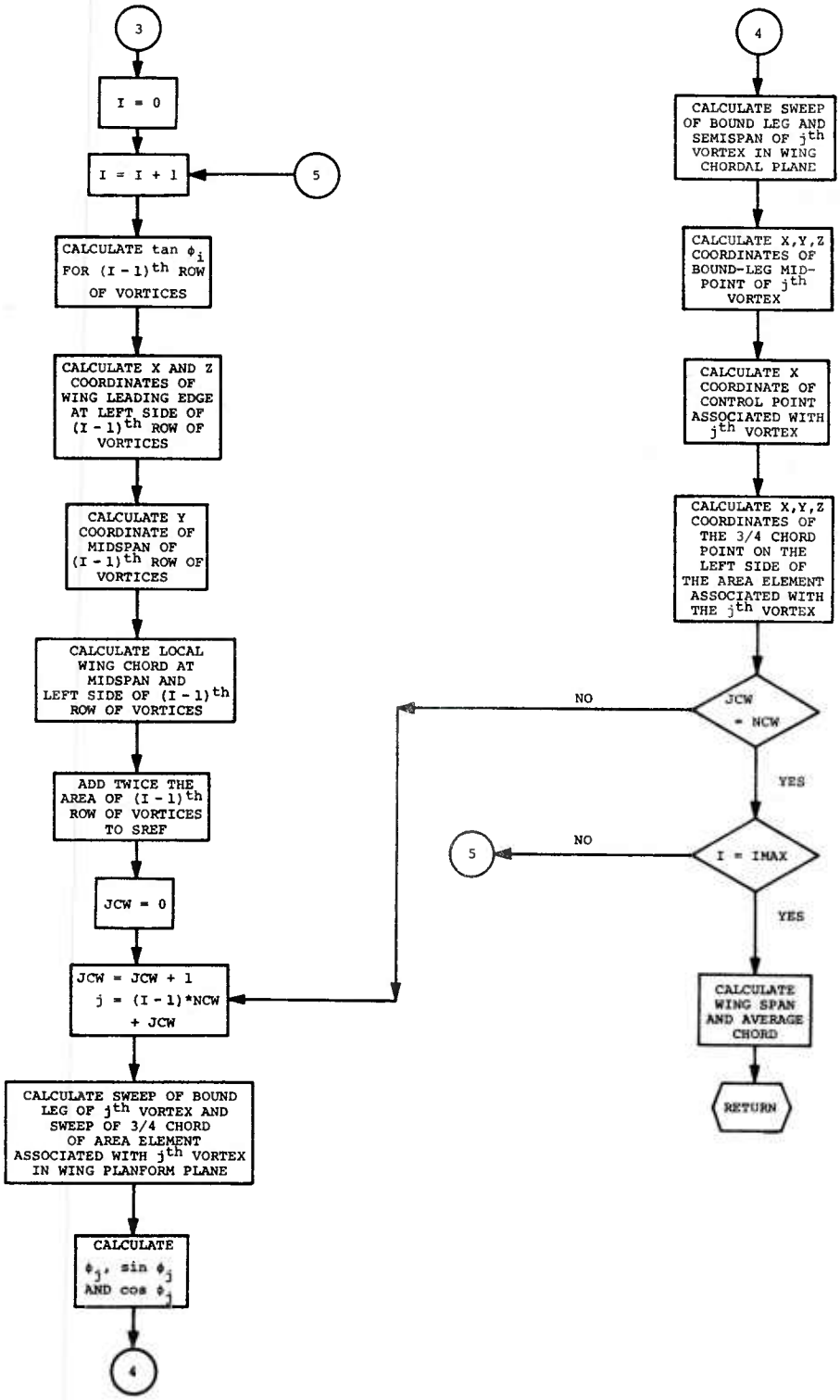
Figure II-17.- Flow chart of subroutine WTHIN.





(a) Page 1.

Figure II-18.- Flow chart of subroutine WVLIN.



(b) Page 2.

Figure II-18.- Concluded.

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13. ABSTRACT

Detailed instructions are presented for using two computer programs which calculate the six-degree-of-freedom trajectories of external stores which are separated from fighter-bomber type aircraft at speeds up to the critical speed. Single and multiple store configurations can be handled by the programs. The first program calculates the source distributions which represent the volume distributions of the fuselage, store(s), and ejector rack if one is present. The second program uses a lifting surface theory to determine a vorticity distribution which represents the wing and pylon loading and calculates the trajectory of the ejected store. This report describes the two programs, presents instructions for preparing input for the programs, describes the output from each program, and presents sample cases.

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14. KEY WORDS	LINK A		LINK B		LINK C	
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Subsonic flow						
Aerodynamic loads						
Flow fields						
Store separation						

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